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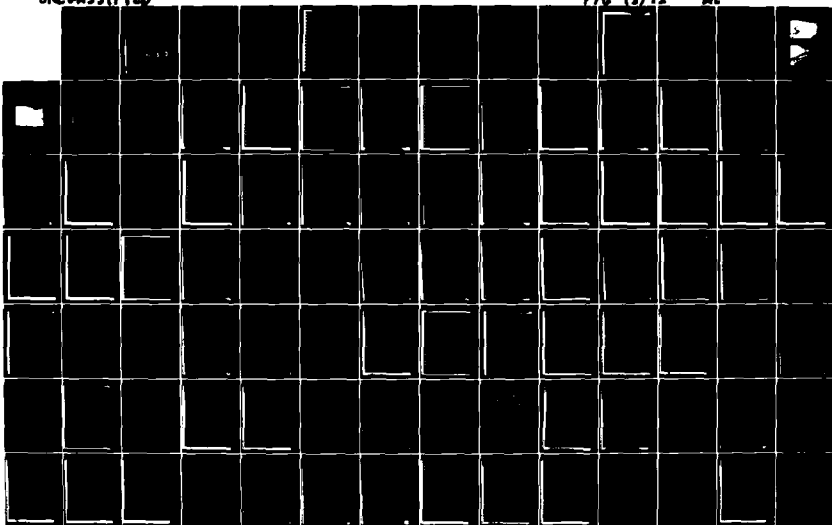
NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
WINSOR DAM (MA 00588)...(U) CORPS OF ENGINEERS WALTHAM
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CONNECTICUT RIVER BASIN
WARE, MASSACHUSETTS

WINSOR DAM MA 00588
QUABBIN SPILLWAY MA 00589
GOODNOUGH DIKE MA 00590

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The structures are all classified as being large in size. The projects are in excellent to good condition. There were no obvious signs of failure or conitions which would warrent urgent remedial treatment. It has a hazard potential of high.		



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02154

REPLY TO
ATTENTION OF:

NEDED

Honorable Michael S. Dukakis
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts 02133

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Dear Governor Dukakis:

I am forwarding to you a copy of the Windsor Dam, Quabbin Spillway & Goodnough Dike Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. In addition, a copy of the report has also been furnished the owner, the Metropolitan District Commission, Commonwealth of Massachusetts, 80 Somerset Street, Boston, Massachusetts 02108, ATTN: Mr. Martin Weis, Chief Engineer.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for your cooperation in carrying out this program.

Sincerely yours,

JOHN P. CHANDLER
Colonel, Corps of Engineers
Division Engineer

Incl
As stated

WINSOR DAM MA 00588
QUABBIN SPILLWAY MA 00589
GOODNOUGH DIKE MA 00590

CONNECTICUT RIVER BASIN
WARE, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

BRIEF ASSESSMENT

PHASE I INVESTIGATION REPORT NATIONAL DAM INSPECTION PROGRAM

Identification No. MA 00588 Winsor Dam
and Name: MA 00589 Quabbin Spillway
MA 00590 Goodnough Dike
Town: Ware
County: Hampshire
State: Massachusetts
Date of Site Visit: 29 June 1978

Quabbin Reservoir was created by the Metropolitan District Commission in the late 1930's by construction of Winsor Dam, Quabbin Spillway and Goodnough Dike. By virtue of both storage and height, the structures are classified as "large" in size.

Winsor Dam and Goodnough Dike are full hydraulic fill earth embankments, having maximum heights of 170 and 135 ft. and lengths of 2640 and 2140 ft., respectively. Quabbin Spillway is an ungated masonry weir, having a maximum height of approximately 14 ft. and an overall length of 405 ft.

The projects are in excellent to good condition. There were no obvious signs of failure or conditions which would warrant urgent remedial treatment.

Hydraulic analyses indicate that the Quabbin Spillway in combination with the auxiliary spillway at Winsor Dam, are adequate in size to safely pass the test flood, calculated from the probable maximum flood, without overtopping Winsor Dam or Goodnough Dike.

Because of the importance of these structures for water supply to the Greater Boston area, because of the high hazard potential in the event of a failure, and because the embankments are hydraulic fill with relatively steep slopes, it is recommended that the MDC undertake a

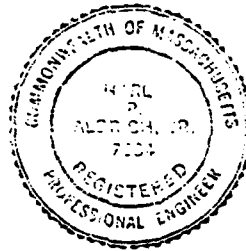
BRIEF ASSESSMENT (continued)

detailed investigation of embankment stability under static and earthquake loading.

HALEY & ALDRICH, INC.

by:

Harl Aldrich
Harl Aldrich
President



This Phase I Inspection Report on Windsor Dam, Quabbin Spillway & Goodnough Dike has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.



CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division

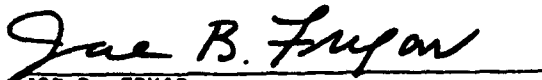


FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division



SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:



JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D. C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I Investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I investigations are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the test flood is based on the estimated "probable maximum flood" for the region (greatest reasonably possible storm runoff), or a fraction thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

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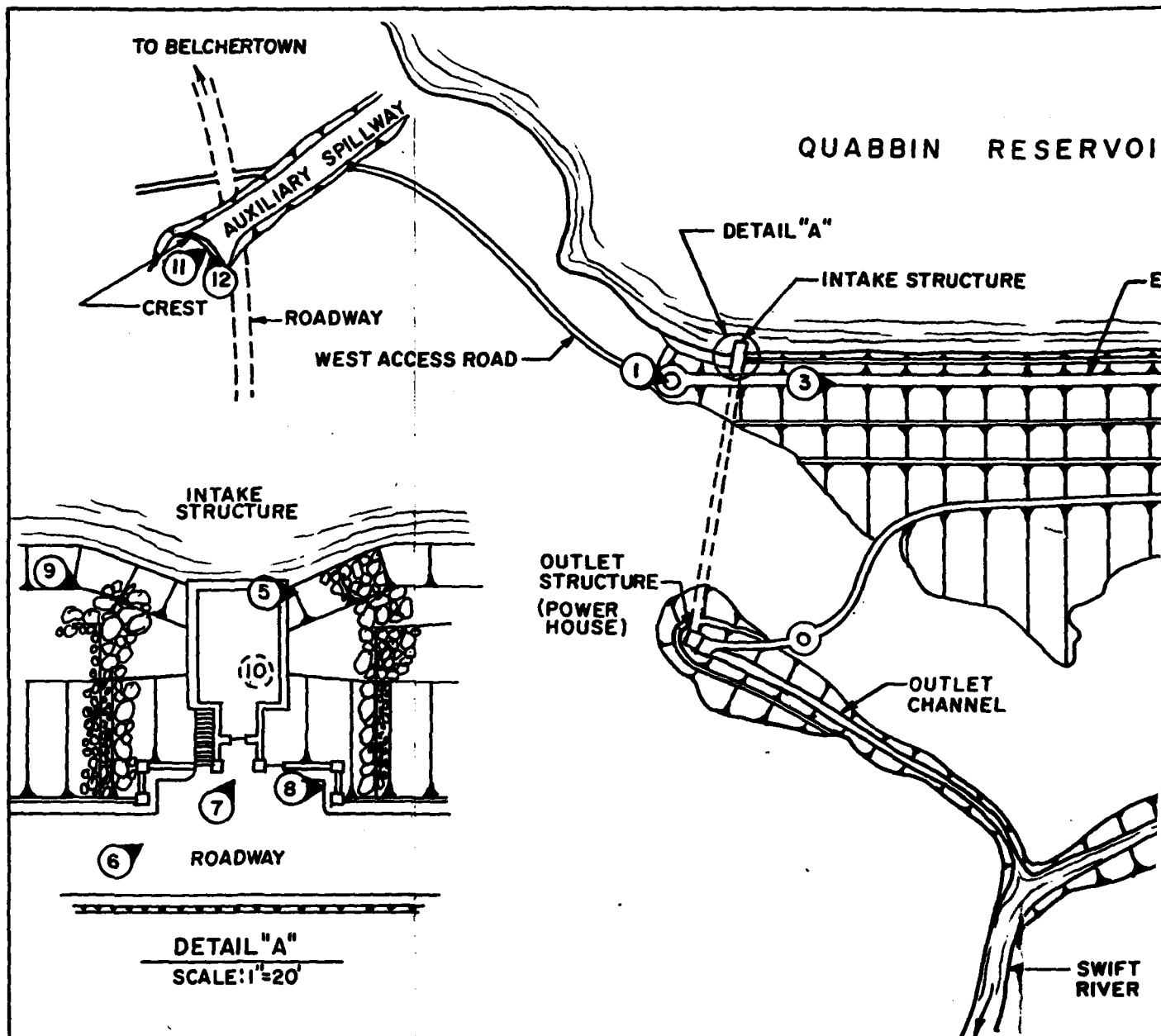
Overview Photo of Winsor Dam



Overview Photo of Quabbin Spillway



Overview Photo of Goodnough Dike



NOTE:

PLAN DEVELOPED FROM M.D.C. CONSTRUCTION DRAWINGS NO. NO. 17, ACC. 24117 SHOWN IN APPENDIX B AND HALEY & ALD ON 29 JUNE 1978.

LEGEND:



PHOTOGRAPH NUMBER AND DIRECTION OF VIEW.

FILE NO. 416000 B28

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

QUABBIN RESERVOIR

KE STRUCTURE

EMBANKMENT ROADWAY

APPROACH
CHANNEL

QUABBIN
SPILLWAY
WEIR

DISCHARGE
POOL

OUTLET
CHANNEL

SPILLWAY
CHANNEL

EAST
ACCESS
ROAD

SWIFT
RIVER

CONSTRUCTION DRAWINGS NO. 2, ACC. 24102 AND
X B AND HALEY & ALDRICH FIELD OBSERVATIONS

WINSOR DAM AND
QUABBIN SPILLWAY
QUABBIN RESERVOIR
SITE SKETCH PLAN

SCALE: 1" = 400' SEPTEMBER 1978

DIRECTION OF VIEW.

APPENDIX C-1

(2)

PHASE I INVESTIGATION REPORT
NATIONAL DAM INSPECTION PROGRAM
WINSOR DAM MA 00588
QUABBIN SPILLWAY MA 00589
GOODNOUGH DIKE MA 00590

I. PROJECT INFORMATION

1.1 GENERAL

A. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region.

Haley & Aldrich, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed were issued to Haley & Aldrich, Inc. under a letter dated 26 April 1978 from Colonel Ralph T. Garver, Corps of Engineers. Contract No. DACW33-78-C-0301 has been assigned by the Corps of Engineers for this work. Camp, Dresser & McKee, Inc. was retained as consultant to Haley & Aldrich, Inc. on the structural, mechanical/electrical and hydraulic/hydrologic aspects of the investigation

B. Purpose. The primary purposes of the National Dam Inspection Program are to:

1. Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.
2. Encourage and prepare the states to initiate quickly effective dam safety programs for non-Federal dams.
3. To update, verify and complete the National Inventory of Dams.

1.2 PROJECT DESCRIPTION

A. Location. Winsor Dam is located on the Swift River, at the boundary between the towns of Belchertown and Ware, Massachusetts. The Quabbin Spillway and Goodnough Dike are located nearby in the town of Ware. The Location Map on page viii shows the location of the three structures.

At the time of construction, a portion of Winsor Dam as well as Quabbin Spillway and Goodnough Dike were located in the Town of Enfield, the corporate existence of which was eliminated when Quabbin Reservoir was constructed.

B. Dam, Spillway, Dike and Appurtenances. Winsor Dam consists of a 2640 ft. long full hydraulic fill earth embankment, an intake structure discharging through a tunnel to an outlet structure and powerhouse, and an auxiliary spillway, as shown in Appendix B-54 and Appendix C-1.

The maximum height of the embankment is about 170 ft. and the crest is approximately 35 ft. wide. A paved roadway on the crest spans the length of the embankment. The normal operating level of the reservoir is El. 530, 20 ft. below the top of the dam. The upstream face is sloped at about 2 horizontal to 1 vertical above a berm at El. 535 and paved with light riprap. Below the berm, heavy riprap was placed at 1.5:1 and flattening to 3:1 below the wave break. The downstream face is grassed and slopes at 2:1, 2.5:1 and 2.75:1 with berms for drainage at the changes in slope. A concrete core wall extends from an elevation about 25 to 30 ft. above the bottom of the dam to the surface of rock, below which is a grout curtain 20 ft. into rock. The embankment is shown in Photos No. 2, 3, 4, 5 and 8 in Appendix C. A profile and a cross-section at the top of the dam are shown in Appendix B-58 and B-59, respectively.

An intake structure, Photo No. 9, is located on the right side. The 157-ft. long "intermediate intake" shown in Appendix B-60 upstream of the intake structure feeds a 68-in. diameter conduit and a 48-in. diameter conduit which go to a power house at the outlet structure downstream. The outlet channel from the power house discharges into the Swift River. Regulating outlets are further described in Section 1.3J.

An auxiliary spillway located beyond the right abutment of Win-

sor Dam consists of a gently sloped grassed approach channel and circular concrete cutoff wall with "quarry faced ashlar" at the crest. This spillway is only intended to provide emergency overflow at El. 536 in case of extreme high water. Photos No. 11 and 12 and Appendix B-61 show details of the auxiliary spillway.

Quabbin Spillway is located approximately 1000 ft. east of the left abutment of Winsor Dam. It consists of an approach channel, a 405 ft. long masonry concrete weir, discharge pool and spillway channel, shown in Appendix B-62 and Appendix C-2.

The approach channel is approximately 80 ft. wide and 650 ft. long, excavated into rock and shown in Photo No. 21. The channel bottom drops 8 ft. from Quabbin Reservoir to the spillway weir.

The spillway weir is 370 ft. long with a crest elevation of 530 and has a 34 ft. 8 in. long side discharge at El. 528. Currently 2 ft. of flashboards are in place on the short section. Refer the Photos No. 13, 14, 16, 19 and 20 for the correct configuration of the weir as shown sketched in Appendix C-2.

The discharge pool was excavated into rock, as was the long spillway discharge channel. The discharge channel has a width of approximately 30 ft. and length of 2300 ft. from the discharge pool to the convergence point with the Swift River. Photos No. 22, 23, 24 and 25 show features of the spillway discharge channel. Cross-sections of excavations for the spillway channel are shown in Appendix B-63.

Goodnough Dike consists of a 2140 ft. full hydraulic fill embankment with no appurtenances. The dike is shown in Appendix B-64 and Appendix C-3.

The maximum height of the embankment is about 135 ft. and the crest is approximately 35 ft. wide. A paved roadway on the crest spans the length of the embankment. The top of the dike is approximately 20 ft. high than the normal operating level of El. 530 at Quabbin Reservoir. The side slopes, zoning, impervious core and grout curtain for the embankment are of the same design and construction as Winsor Dam. Photos No. 27 through 32 show the Goodnough Dike embankment. Cross-sections and a profile on the centerline of the dike are shown in Appendices B-67 and B-68, respectively.

C. Size Classification. Winsor Dam, Quabbin Spillway and

Goodnough Dike impound a reservoir with a maximum storage estimated to be 1,810,000 acre-feet. Winsor Dam and Goodnough Dike have a maximum height of 170 and 135ft., respectively. Storage of more than 50,000 acre-feet and/or height greater than 100 ft. classifies these structures in the "large" category according to guidelines established by the Corps of Engineers.

D. Hazard Classification. The structures are currently classified as having a "high" hazard potential in the Corps of Engineers National Inventory of Dams. A failure of Winsor Dam or Goodnough Dike would cause a loss of life estimated in previous inspection reports between 2 and 300 persons. A review of the downstream conditions indicate that between 25 and 100 residential, industrial and commercial properties would be inundated in the developed areas of Beaver Lake, Palmer, and Three Rivers. There is no question that the economic losses associated with such an event would be catastrophic. A failure of Quabbin Spillway, however, would result in a much lesser flow which would not present any significant hazards downstream. Therefore, it is recommended that the "high" hazard potential classification be retained for the Winsor Dam and Goodnough Dike and that a "low" hazard classification be assigned to Quabbin Spillway.

E. Ownership. The three structures are owned by the Metropolitan District Commission, Water Division, of the Commonwealth of Massachusetts. The owner's address is 20 Somerset St., Boston, MA 02108

F. Operator. The following individual has day-to-day responsibility for the operation of the project:

Mr. Harold E. Mellin, Jr.
Metropolitan District Commission
Winsor Dam
Ware Road
Belchertown, MA 01007
(Phone: 413/323-6921)

Mr. Mellin represented the owner during this investigation.

G. Purpose of Dam. The primary purpose of Quabbin Reservoir is to provide a potable water supply for the Metropolitan Water District, a group of more than 30 cities and towns in the Greater Boston Area.

In addition, the reservoir and reservation provide recreation in the form of boating, fishing, hiking and picnicking. The Quabbin Reservoir Reservation is also an important wildlife habitat.

H. Design and Construction History. The design and construction history of Winsor Dam, Quabbin Spillway and Goodnough Dike which form the Quabbin Reservoir is well documented due to the size and importance of the project. Several technical papers addressing this interesting work were published in professional journals. The following narrative is based largely upon the papers by Dore¹ (1935) and Winsor² (1938).

The idea of forming Quabbin Reservoir to supply water to the City of Boston was conceived by the MDC prior to 1920. A number of test borings were made in 1920 and 1921 as part of a preliminary investigation concerning the general location of the dams. By 1929, a large number of borings, described in detail by Hammond³ (1929) confirmed that the general sites chosen for the project were overlain by deep (greater than 100 ft.) glacial deposits of pervious sands, gravels, cobbles and boulders.

The valleys chosen for Winsor Dam and Goodnough Dike are long and wide, requiring construction of earth embankments rather than concrete gravity dams. Investigation of possible borrow areas revealed abundant materials suitable for earth-type dam construction. The water tables at the two sites were between 120 and 130 ft. above bedrock, presenting an additional construction consideration relating to excavation through pervious glacial deposits. It was decided to sink two exploratory caissons, one at each site, to further investigate the overburden characteristics, the feasibility and cost of open and

1

"Design and Progress on the Construction of Dams for Quabbin Reservoir" by Stanley M. Dore, Journal of the Boston Society of Civil Engineers, July 1935.

2

"Quabbin Reservoir - Recent Developments in the Construction of the Ware-Swift Water Supply for the Metropolitan District" by Frank E. Winsor, Journal of the Boston Society of Civil Engineers.

3

"Diamond Drill Borings for the Swift River Dams" by N. Leroy Hammond, Journal of the Boston Society of Civil Engineers, January 1929.

pneumatic caisson construction and the possibilities of lowering the groundwater by pumping. The contract for this work was awarded in September 1931, and was completed about a year later.

The exploratory caissons measured 32 ft. long by 12 ft. wide. Open dredging methods proved unfeasible below depths of about 50 ft. in the dense granular soils. A compressed air method was then successfully adopted for sinking the caissons. Air locks were installed over the working wells and maximum air pressures of about 33 psi were used to advance and seal the caisson to ledge "in the dry" about 70 ft. below river level at the Winsor Dam site. Information obtained from the sinking of these caissons and the pumping carried on from them indicated the construction method was feasible for use as a cutoff wall at both sites and the most economical.

While the sinking of the exploratory holes was underway, work to divert the Swift River during construction was begun at the Winsor Dam site. The stream control works consisted mainly of the 30-ft. effective diameter rock tunnel under the right abutment. The conduit was concrete lined and about 1200 ft. long. The Swift River was diverted through the tunnel in June 1933.

Two exploratory caissons, in addition to the one already built, were excavated pneumatically and sealed to rock at the Winsor Dam site. Pumping from these three caissons from November 1934 to January 1935 lowered the water table to approximately 90 ft. below the river level and maintained it at that position until the start of core wall construction in May 1935.

The entire cutoff wall at Winsor Dam was formed by a total of forty reinforced concrete caissons, all except the first one being 45 ft. long by 9 ft. wide. Groundwater was effectively controlled by pumping from wells in completed caissons and wellpoints and sumps upstream of the construction. Due to the effects of pumping, less than 20% of the caisson work was done under compressed air conditions. Since the overburden soils became more pervious with depth, it was decided that the caissons would be sealed to rock and grout curtains installed 20 ft. into rock. The overburden and geological conditions at the site are shown in Appendices B-55, B-56 and B-57.

Prior to sinking the caissons, an open trench was excavated across the valley to a depth of about 30 ft. The trench was subsequently filled with impervious "topsoil" and compacted around the concrete core wall in six-inch thick lifts with sheepsfoot rollers. The concrete core wall extended a minimum of 25 ft. into this refill. This foundation work was completed in the early summer of 1936.

Full hydraulic fill construction of the embankments was considered to be the most economical and desirable for stability and uniformity of the slopes. Sluicing of the embankments at Winsor Dam began in 1936. Materials were brought to the hog box on belt conveyors and mixed with water jets to flow into a steeply sloped trough towards the sluicing line. The quality of the core material being pooled was continuously monitored and checked by sounding with a rod and sampled for inspection and laboratory analysis. Placement of the 4,000,000 cubic yards of fill required for Winsor Dam was completed in 1939. The top 30 ft. of dam embankment was placed by rolled-fill methods. The foundation and embankment are shown in profile in Appendix B-58. A cross-section through the top of the dam is shown in Appendix B-59.

Quabbin Spillway is located in a natural high valley to the east of the left abutment of Winsor Dam. This site was structurally desirable because the spillway channel would be formed entirely in rock from the spillway weir to the Swift River. A spillway weir length of about 400 ft. was chosen to allow passage of floods up to 10,000 cfs without flooding out the rock discharge channel. It was believed that floods up to 15,000 cfs could be carried with no important scour of the earth banks above the rock channel. A plan of the spillway is shown in Appendix B-62 and cross-sections are included in Appendix B-63.

Goodnough Dike was constructed in the period from approximately September 1931 to July 1938. The dike is nearly identical in design and construction to Winsor Dam. The core wall was built as previously described by excavating an open-cut trench, by sinking from the bottom reinforced concrete caissons sealed to each other and to rock, grouting below the concrete core wall, and by filling the wells of the caissons and the open-cut trench with impervious soils. The geological conditions at the dike site are shown in Appendices B-65 and B-66.

Beaver Brook was initially carried past the construction site in a wooden flume about 350 ft. long. It was then dried up upstream for over 1,000 ft. by subsequent pumping, and eventually the brook flow was through an 18-in. pipeline until its subsequent diversion across the divide to the Swift River. The groundwater surface was lowered approximately 90 ft. during foundation construction.

Placement of the embankment by full hydraulic methods began in December 1934 and was completed prior to July 1938. The method

of placement was substantially the same as that for Winsor Dam. A profile on the centerline of the dike and typical cross-sections are shown in Appendices B-67 and B-68, respectively.

1.3 PERTINENT DATA

Elevations shown on all record drawings and as used in this report are referenced to Boston City Base datum. To convert to the National Geodetic Vertical Datum (NGVD), subtract 6.049 ft. from elevations which are on Boston City Base.

A. Drainage Area. The Quabbin Reservoir was formed in the 1930's by impounding the watersheds of the East, Middle and West Branches of the Swift River. The 186 square mile drainage basin which is tributary to the Quabbin Reservoir Spillway consists of heavily forested rolling terrain. In addition to this, limited diversion from the Ware River watershed of 98 square miles is discharged to the Quabbin Reservoir between October 15 and June 15 when flows on the Ware River exceed 85 mgd.

The water surface area of the reservoir at normal pool elevation is 39.4 square miles or 21 percent of the 186 square mile watershed.

B. Discharge at Damsite. Following completion of the impoundment works in 1940, it took 7 years before the reservoir was filled to its capacity of 412 billion gallons. Quabbin's level fell to 45 percent of capacity in 1967, following a six-year drought. No spillway discharge occurred from 1961 to 1976. The maximum recorded spillway discharge elevation was 531.03 on April 18, 1953. Based on the available rating curve, this stage corresponds to a discharge of about 1600 cfs. The longest continuous spillway discharge occurred between April 16 and May 7, 1978 with a maximum reservoir elevation of 530.34 (270 cfs) on April 24 and 25, 1978.

In addition to Quabbin Spillway at crest El. 530.0, there is an auxiliary spillway at crest El. 536.0. At this elevation, the maximum discharge over Quabbin Spillway is reported to be 15,000 cfs. Discharges in excess of this amount will produce water surface elevations in the reservoir above El. 536.0 at which point the auxiliary spillway will begin discharging.

An additional 70 to 75 mgd discharge capacity is available through the generating facilities at the intake structure.

C. Elevation (ft. above Boston City Base)

1. Top Winsor Dam and Goodnough Dike.....	530.0
2. Maximum pool-design surcharge....	536.1
3. Design surcharge - original design..	536+
4. Full flood control pool.....	536.1
5. Recreation pool.....	530.0
6. Spillway crest.....	530.0
7. Upstream portal invert diversion tunnel.....	Unknown
8. Streambed at centerline Winsor Dam.....	380.0
Goodnough Dike.....	415.0
9. Maximum tailwater.....	526.0

D. Reservoir

1. Length of maximum pool.....	18.0 miles at El. 536.0
2. Length of recreation pool.....	17.9 miles
3. Length of flood control pool.....	18.0 miles

E. Storage (acre-feet)

1. Top of dam.....	1,810,000 (Est.)
2. Test flood pool.....	1,417,600 (Est.)
3. Flood-control pool.....	1,417,600 (Est.)
4. Recreation pool.....	1,265,200 (Est.)
5. Spillway crest.....	1,265,200 (Est.)

F. Reservoir Surface (acres/sq. miles)

1. Top of dam.....	29,100/45.5 (Est.)
2. Test flood pool.....	26,120/40.8 (Est.)
3. Flood control pool.....	26,120/40.8 (Est.)
4. Recreation pool.....	25,216/39.4 (Est.)
5. Spillway crest.....	25,216/39.4 (Est.)

G. Winsor Dam and Goodnough Dike

1. Type.....	Hydraulic Fill
2. Length Winsor Dam.....	2640 ft.
Goodnough Dike.....	2140 ft.

3. Height	
Winsor Dam.....	170 ft.
Goodnough Dike.....	135 ft.
4. Top Width.....	35 ft.
5. Side Slopes	
Upstream.....	2:1, 1.5:1 and 3:1
Downstream.....	2:1, 2.5:1 and 2.75:1
6. Zoning.....	Gradual, typical of hydraulic fill
7. Impervious core.....	Silt and clay puddle
8. Foundation cutoff.....	Concrete caisson core wall to rock
9. Grout curtain.....	20 ft. into rock from bottom of caisson

H. Diversion and Regulating Facilities. Not applicable

I. Quabbin Spillway

1. Type.....	Masonry, round crest, with side channel discharge
2. Length of weir.....	34 ft. 8 in. at El. 528 370 ft. at El. 530
3. Crest Elevation.....	530.0
4. Gates.....	2 ft. of flashboards on short section
5. U/S Channel.....	6 ft. rise in 500 ft.
6. D/S Channel.....	20 ft. drop in 700 ft. then 60 ft. drop in 100 ft.

Auxiliary Spillway

1. Type.....	3 ft. wide quarry stone, 0.5 ft. high, both U/S and D/S
2. Length of Weir.....	240 ft.
3. Crest Elevation.....	536.0
4. Gates.....	None
5. U/S Channel.....	1.5 ft. rise in 685 ft.
6. D/S Channel.....	1.5 ft. drop in 200 ft.

J. Regulating Outlets at Winsor Dam. Winsor Dam was originally constructed with three intakes. A "Lower Intake" was constructed during an early contract to provide a tunnel for stream diversion during construction of the dam. This intake tunnel now has a concrete plug below the intake structure and is therefore inactive. An "Intermediate Intake" with invert at El. 465 and an "Upper Intake" at El. 499 and located immediately upstream of the intake structure were also provided.

Fish screens with a sill at El. 471.75 and top of screened opening at El. 501.75 were installed in 1974. The balance of the intake channel was shut off during the installation of the screens. This effectively allows the use of the 157-foot long intermediate intake only. This intake is a reinforced concrete section 7 ft. wide by 8 ft. high. The intake feeds a 68-in. diameter conduit and a 48-in. diameter conduit which go to the power house. The 68-in. diameter conduit is installed inside the former stream diversion tunnel. Control at the inlet structure is by a 48-in. diameter 300 lb. test C.I. gate valve with Ludlow geared operator on a floor stand and a 48-in. by 72-in. sluice gate with Ludlow geared operator.

The two conduits are interconnected at the power house with a 36-in. pipe. The water may be fed by a 48-in. line to the Chicopee Aqueduct, may be discharged through the turbine generator or may be discharged through a 33-in. pipe bypassing the turbine. Control at the power house is by a 68-in. gate valve with geared operator, two 48-in. gate valves with geared operators, three 36-in. gate valves with geared operators, one 48-in. control valve with electric motorized operator and one 33-in. control valve with electric motorized operator. Orifice plates have been reported to be installed in the lines due to cavitation problems with the control valves.

I. Normal Operating Procedures. Quabbin Reservoir controls are used primarily to transmit water to the metropolitan area of Boston and the local communities of Chicopee through the Quabbin and Chicopee Aqueducts, respectively. They are operated based on demand. Also, a minimum of 20 MGD is released to the Swift River as required by law for low flow augmentation.

The water is released from Quabbin Reservoir via a 68-in. conduit and a 48-in. conduit interconnected with a 36-in. pipe at the power house. There the water may be discharged from the conduits through the turbine generator or through bypass pipes.

The gates for these conduits are at the power house. Additional gates are at the intake structure. The gates at the intake structure are normally left open and test operated twice a year.

II. ENGINEERING DATA

2.1 DESIGN RECORDS

Pertinent contract drawings for Winsor Dam, Quabbin Spillway and Goodnough Dike are listed and included in Appendix B. No original design criteria and calculations for the structures were available from the MDC. However, some items regarding the design for each structure are mentioned in the numerous articles published in technical journals about the subject projects.

2.2 CONSTRUCTION RECORDS

The original construction contract documents for the structures are listed in Appendix B-5. Pertinent drawings from these contracts are also listed and included in Appendix B. Many details of the actual construction are described in published technical papers and reports such as those in the Journal of the Boston Society of Civil Engineers and the Annual Report of the Metropolitan District Water Supply Commission.

Details shown on the contract drawings are in good agreement with field observations, with the exception of Appendix B-62 which shows an incorrect configuration for the spillway weir. The proper shape of the weir is shown on the Site Sketch Plan, Appendix C-2 and in Photo No. 13.

No construction modifications to the original structures following their completion in the 1930's are known to have taken place.

2.3 OPERATION RECORDS

Operational records kept by MDC Quabbin personnel are based primarily on daily reservoir discharges at the Winsor Dam outlet structure and test runs of the equipment.

2.4 EVALUATION

A. Availability. Design and construction records are available at the MDC, 20 Somerset St., Boston, MA 02108. Operation records are available at the MDC Quabbin, Ware Road, Belchertown, MA 01007.

B. Validity. With the exception of the change in configuration of the spillway weir described in Section 2.2, the contract documents appear to represent the the features of the presently existing structures, based on visual field observations.

C. Adequacy. The available data, in combination with the visual examinations described in the following section, are adequate for the purposes of the Phase I Investigation.

III. VISUAL EXAMINATION

3.1 FINDINGS

A. General. The Phase I visual examination of Winsor Dam, Quabbin Spillway and Goodnough Dike was conducted on 29 June 1978.

In general, the projects were observed to be in excellent to good condition. The earth embankments, spillways and intake structures are well maintained. A few minor deficiencies requiring correction have been noted.

Visual inspection checklists for the three structures are included in Appendix A and selected photographs of the projects are given in Appendix C.

B. Winsor Dam. Winsor Dam includes a large earth embankment, an intake structure and an auxiliary spillway. Photographs of this structure are numbered 1 through 12 in Appendix C.

The hydraulic fill embankment is in excellent condition. There was no visual evidence of settlement, lateral movement, seepage or other serious defects. The downstream slope, Photos No. 2 and 3, is covered by grass which is mowed frequently. Both the light and heavy riprap on the upstream slope appear to be stable and in good condition, with little weathering, Photos No. 4 and 5.

The roadway and stone walls across the crest of the embankment are in excellent condition. The near perfect horizontal alignment of the wall is shown in Photo No. 3. The roadway crest and walls are somewhat higher in grade toward the "center" of the embankment than they are at the abutments. At the time of construction, the embankment at its highest point above original ground, was built approximately 3 ft. higher than El. 550, the proposed final embankment grade. The cambered crest was established to allow for future settlement from consolidation of the hydraulic fill.

Settlement of the crest has been monitored at eight observation points located at the top of the riprap slope, immediately upstream of the stone wall. An MDC drawing which summarizes embankment settlements from 1939 to the last reading on 26 June 1973, is included in Appendix B-69.

The embankment, at its highest point between Sta. 18 and 21, settled 1.1 ft. between 1939 and 1952 (13 years). In the following 21 years to 1973, an additional 0.45 ft. of settlement occurred. Typically, settlements at the ends of the embankment are less.

Settlement of the embankment is evident where it interfaces with the intake structure, Photo No. 6. Photo No. 7 shows from 6 to 8 in. of settlement relative to masonry walls at roof level. In addition, settlement and lateral movement on the upstream slope are indicated by a crack in the stone masonry wall located immediately left of the intake structure, Photo No. 8. The wall at this location had been repaired in the past by pointing the crack.

The intake structure (control house), Photo No. 9, is in good to excellent condition and well maintained. There is some incidental rusting on the interior columns and some staining on the interior wall block. The exterior masonry does evidence loss of mortar from the lower joints. There is some efflorescence along the lower portion of the structure.

The power house lower floor is in excellent to good condition. Efflorescence is present on the walls near the slab. Water from an unknown source was present on the floor. The upper floor is also in good condition. No efflorescence was noted on the walls at this floor. The bond beam at the top of the wall does exhibit a number of shrinkage cracks. The underside of the roof appears to be stained.

The former diversion tunnel could not be inspected in detail due to the lack of internal illumination. However, a number of cracks in the lining were observed. Moderate leakage was observed through the roof at what appeared to be an old patch along a crack located approximately 450 ft. from the power house. The condition of the lining of this tunnel is estimated to be from good to fair.

The outlet channel downstream of the power house is in satisfactory condition.

The auxiliary spillway, located right of the MDC administration building, is in excellent condition. The approach channel to the curved spillway is grass, recently mowed. There are three trees in the channel as shown in Photo No. 11. In addition, a gravel roadway which crosses the approach channel immediately upstream of the spillway weir creates a minor obstruction to flow, especially at the left side where some fill has been placed.

The crest of the weir itself is in good condition, Photo No. 12.

C. Quabbin Spillway. The Quabbin Spillway includes a masonry weir, a short approach channel and a long discharge channel to the Swift River. Photographs of this structure are numbered 13 through 25 in Appendix C.

The spillway masonry is in excellent to good condition. Vegetation is present in several spots along the top masonry joint. The bottom or bed joint of the masonry has been eroded somewhat. In addition, some of the lower joints in the weir have lost mortar.

Three vertical cracks were noted in the highest portion of the weir, one at each end and one near the center. The crack near the center is shown in Photos No. 17 and 18. Spot efflorescence is present on the downstream face of the highest portion of the weir. Moisture was noted in local areas along the downstream face of the weir, at cracks and at the near vertical junction of the weir with bedrock. At one location near the south end of the weir where its height is only a few feet, a fine amount of water is shooting out approximately 3 in.

The upstream face of the weir was not observable due to the high reservoir level.

The access bridge to the flashboards and the flashboards are well maintained and in good to excellent condition, Photos No. 19 and 20. The flashboard guides are in excellent condition.

The approach channel to the spillway weir is in satisfactory condition, Photo No. 21.

The discharge pool and discharge channel from the spillway are generally in good condition. Seepage was noted from joints in the rock and from 2.5-in. diameter drill holes at locations immediately below the weir. Photo No. 15 shows water flowing from one such drill hole.

At the entrance to the discharge channel, large blocks of rock have fallen from the left face of the rock cut, Photo No. 23. The right side, Photo No. 24, is in a more stable condition. The stability of the right side is enhanced by the generally infrequent spacing and favorable attitudes of joints in the gneiss making up the channel face, Photo 22. Some large blocks of gneiss, visible by the man in

Photo No. 24, appear to have dislodged from a fault plane at the entrance to the channel. Another rockfall occurs along the right side of the channel, about 280 ft. downstream from the channel entrance. The volume of rock is not large and does not constitute an appreciable obstacle to flow in the channel. At a point about 360 ft. south of the channel entrance, along the right side, relatively minor amounts of fault and joint-bounded rock blocks appear capable of falling as a result of future frost action. The maximum volume at a given location that could be produced by such frost effects is estimated at 75 cubic yards. Such a volume, occurring at one instance, would probably result in a cross-channel debris mound less than 15 ft. in height.

Rock falls along the left channel face have occurred to a greater volume than on the right side primarily due to adverse dips on many of the joints in the hornfels, gneiss, and schist exposed on the face. Such joint surfaces dip into the channel at angles of from 40 to 70 degrees from the horizontal. Rock fall debris from these joints occur at the entrance to the channel and at distances of about 85 to 110 ft., 235 ft., and 285 ft. south of the channel entrance.

The general condition of the discharge channel downstream of the arch bridge is shown in Photo No. 25.

B. Goodnough Dike. Goodnough Dike is a large earth embankment without appurtenant structures. Photographs of the dike are numbered 26 through 33 in Appendix C.

The hydraulic fill embankment is in excellent condition. There was no visual evidence of settlement, lateral movement or other serious defects. The downstream slope is covered with grass, with a few small bare spots, which is mowed frequently. Both the light and heavy riprap on the upstream slope appear to be stable and in good condition, with little weathering, Photo No. 32.

Two wet areas occur at the downstream toe of the dike, where the embankment is highest. The extent of the wet areas are defined by grass which has not been mowed, as shown in Photos No. 29 and 30. No flow was observed into or from the wet areas, and free water in small puddles was clear. It is understood that these areas are wet seasonally, and are apparently not related to reservoir water levels. Water was observed to be seeping through the asphalt concrete lining for a drainage ditch which runs parallel to the dike toe downstream of the wet area. This condition is shown in Photo No. 31. Water flows into a drop inlet shown near the center of Photo No. 30.

The roadway and stone walls across the crest of the embankment, Photo No. 27, are in excellent condition. Similar to Winsor Dam, Goodnough Dike was constructed with a camber, raising the crest above the nominal design grade at El. 550, to allow for settlement.

Settlement of the crest has been monitored at seven observation points, the protective casing for one of which is shown in Photo No. 33. The MDC drawing which summarizes embankment settlements from 1939 to the last reading on 26 June 1973, is included in Appendix B-70.

The embankment at his highest point between Sta. 17 and 20, settled about 1.2 ft. between 1939 and 1952 (13 years). In the following 21 years to 1973, an additional 0.4 and 0.3 ft. of settlement occurred at Sta. 17 and Sta. 20, respectively. Settlement at Sta. 17 was about 0.1 ft. greater than would have been expected from data available through 1952.

E. Quabbin Reservoir Area. The reservoir was not examined except for areas near Winsor Dam and Goodnough Dike. However, the Quabbin reservation and watershed are generally wooded. In this terrain, it is highly unlikely that landslides into the reservoir and/or surface erosion would be significant and would in any way endanger the safety of the structures.

F. Downstream Channels. The river channel immediately downstream of discharge channels from the Winsor Dam power house and Quabbin Spillway is the natural bed of the Swift River.

For several hundred yards downstream of Goodnough Dike, the former Beaver Brook channel is flat, wide and swampy with ponded water. Few trees have grown in this environment.

3.2 EVALUATION

Based on a visual examination of Winsor Dam, Quabbin Spillway and Goodnough Dike, the projects are well-maintained and in excellent to good condition. Minor deficiencies which have been observed should not have a serious effect on the performance or safety of the structures.

IV. OPERATIONAL PROCEDURES

4.1 PROCEDURES

The primary purpose of the three projects is to impound and store runoff in Quabbin Reservoir for the water supply of the Metropolitan Boston area. A degree of control of the reservoir water surface elevation can be exercised by discharging water through a turbine generator at the power house and/or a 33-inch bypass line into the Swift River. The law requires that the MDC release a minimum of 20 MGD to the Swift River. The reservoir level is also effected by the flow delivered to the Quabbin and Chicopee Aqueducts. Other than these controls, the maximum reservoir level is controlled by Quabbin Spillway weir crest at El. 530.0. (Flashboards can be removed from a 34 ft. - 8 in. length of the weir which would lower the water level to El. 528.0.)

4.2 MAINTENANCE OF DAM

The Winsor Dam and Goodnough Dike embankments are regularly maintained by MDC field forces based at Winsor Dam in Belcher-town, MA.

4.3 MAINTENANCE OF OPERATING FACILITIES

The equipment is well maintained and operated routinely, as required, to deliver water to the aqueducts, generate power and meet discharge requirements to the Swift River. Other equipment is test-operated at set intervals. No equipment was specifically operated during the visual examination on 29 June. The equipment was reported to be in good operational condition. It was also reported that a problem had existed with control valve cavitation at the power house and that orifice plates have been installed.

4.4 WARNING SYSTEMS IN EFFECT

There is no formal warning system in effect in the event of a failure or partial failure of the structures. The operations staff indicated that they do have radio communication capabilities and in case of difficulties, would warn the nearby civil defense center and the Metropolitan District Commission Headquarters.

4.5 EVALUATION

The operational procedures and dam and dike maintenance are satisfactory.

For a project of this size and importance, where a failure would cause major loss of life and property damage, a formal emergency preparedness plan and warning system should be adopted.

V. HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

A. Design Data. The Quabbin Reservoir was created in the 1930's by the MDC with the construction of Winsor Dam, Quabbin Spillway and Goodnough Dike. Proposed construction drawings for the facilities were found but only limited hydraulic/hydrologic design parameters have been located.

Hydraulic/hydrologic information contained in the July 1935 BSCE Journal, Vol. XXII, No. 3, indicates that a runoff of 12 inches in 24 hours would result in a spillway discharge of 9,000 cfs. The same article states that the spillway approach channel was designed to convey 15,000 cfs, at which point the reservoir water surface would be El. 536.0 and the auxiliary spillway would begin discharging.

The size classification of the project is "large" as the height is greater than 150 ft. and the storage is 412 billion gallons (1,264,000 acre-feet). Since the estimated loss of life in the event of failure had been previously estimated to be between 2 and 300 persons, the hazard potential classification is "high". Consequently, the recommended test flood is the probable maximum flood (PMF).

B. Experience Data. The peak inflow PMF was estimated by using the peak flow rate for rolling terrain, as developed by the Corps of Engineers, New England Division, and developing a unit hydrograph based on the September 1938 flood on the East Branch Swift River near Hardwick, Massachusetts, for the land portion of the drainage area which is approximately 146 square miles. To this inflow (peak rate of 134,000 cfs), the PMF resulting from 23 inches of rainfall in 6 hours was distributed over the area of the reservoir and added. The resulting peak inflow was determined to be 226,800 cfs. This peak inflow was routed through the reservoir and the PMF outflow was determined to be 15,200 cfs using both the main and auxiliary spillways. To date, the maximum spillway discharge has been approximately 1600 cfs.

C. Visual observations. No modifications have been made to the Quabbin Spillway since it was constructed in the 1930's. Two feet of flashboards were in place on the 34 ft. -8 in. section of spillway at the time of the inspection and the water surface elevation was

529.73. The spillway and its associated approach channel appear to be in excellent condition. The left wall of the discharge channel shows signs of weathering with fallen rock on the floor of the channel. However, the slope of the discharge channel at this location is sufficiently steep that the rock debris should not cause any hydraulic problems.

D. Overtopping Potential. The stage-discharge relationship for the spillway utilizes the spillway rating curve developed by the MDC for spillages up to 3 feet, to El. 533.0. Between El. 533.0 and El. 536.0, a straight line interpolation was made recognizing the stated design discharge of 15,000 cfs at a maximum pool of El. 536.0.* Above this level, the auxiliary spillway will pass flows from an extreme flooding event.

Neglecting the capacity of the auxiliary spillway channel, it was determined that the PMF would generate a peak outflow rate of 16,300 cfs which would cause the water level in the reservoir to rise to El. 536.54. Considering the additional capacity afforded by the auxiliary spillway, treating same as a broad-crested weir, the maximum water level in the reservoir is lowered to El. 536.07 (peak outflow equals 15,200 cfs). Therefore, the main spillway in combination with minimal usage of the auxiliary spillway is adequate for the PMF. Since the crest of the dam is approximately 14 ft. above maximum water level, there is no possibility of overtopping.

E. Evaluation. Passage of the PMF by the main spillway with a minor portion of the flow over the auxiliary spillway should offer no flooding problems in the immediate area of the dam. The main spillway discharge channel, which is excavated in rock, has a base width in excess of 30 ft. with bottom slopes no less than 1.0 percent upstream of the arch bridge. Just downstream of the bridge, the channel bottom drops more than 50 ft. in less than 100 ft. to form a cascade while downstream, the discharge channel continues in rock with a base width in excess of 30 ft. with the bottom slope averaging 6.0 percent before flattening and merging with the original streambed of the Swift River. Downstream of this point, the Swift River Channel has ample capacity for the PMF flows from the main and auxiliary spillways as well as any contribution from the power station discharge channel. In conclusion, the spillway and downstream channels are more than adequate to pass the routed PMF as developed in the Guidelines.

* "Design and Progress on Construction of Dams for Quabbin Reservoir" by Stanley M. Dore, Journal of the Boston Society of Civil Engineers, July 1935, Pg. 173.

The estimated peak failure outflow should Quabbin Spillway fail is 13,000 cfs. Since this outflow is less than the test flood, the downstream channels and the Swift River are more than adequate to handle a failure of this structure.

Because of Quabbin Reservoir's vast storage capacity, as well as the height of both the Winsor Dam and Goodnough Dike, a failure of either the dam or dike would result in significant downstream damage as well as loss of life.

If Winsor Dam or Goodnough Dike were to fail, the peak outflows have been estimated (using "Rule of Thumb" guidelines developed by the C. of E.) to be 1,533,000 cfs for Winsor Dam and 958,000 cfs for Goodnough Dike. Since the effects of these flood waves would be experienced for many miles downstream, flood routing is beyond the scope of this investigation. Nevertheless, the following qualitative analysis is presented to indicate the magnitude of the downstream hazard potential.

Failure of Goodnough Dike would result in rapid inundation of Peppers Mill Pond one mile downstream, after which the flood wave would likely scour out a section of Route 9 to convey the flows which would be greatly in excess of the capacity of the existing 12 ft. wide by 9 ft. high multi-plate arch which carries Beaver Brook beneath Route 9. About 2 miles downstream of Goodnough Dike, the flood wave would enter Beaver Lake where it would be dissipated somewhat, but not before damage to houses and cottages around Beaver Lake and possible loss of life. Downstream of Beaver Lake, the flood wave would flow through a swampy area before the confluence with the Ware River about one mile downstream of Beaver Lake.

Failure of the Winsor Dam would produce a flood wave which would first scour out a section of Route 9, since the existing Swift River bridge opening would not be adequate to convey the flood flows. The State Fish Hatchery about one-half mile downstream of Route 9 would next be affected including a few houses along the river valley in the immediate area. About 4 miles downstream of Route 9, the flood wave would reach the village of Bondsville in the town of Palmer. The flood flow would pass both the upper and lower dams in Bondsville and for the most part not affect too many homes here as most of them are 20-40 ft. above the river bed. More damage would likely occur just downstream of where the Swift River meets the Ware River in the village of Three Rivers, where some of the housing is relatively low with respect to the river bed.

VI. STRUCTURAL STABILITY

6.1 EVALUATION OF EMBANKMENT STRUCTURAL STABILITY

A. Visual Observations. There was no visual evidence of embankment instability at either Winsor Dam or Goodnough Dike during the site of examination on 29 June 1978. Seepage at Goodnough Dike, as evident by wet areas at the toe of the dike, is not considered a potential hazard to the stability of the downstream slope.

B. Design and Construction Data. MDC drawings are available which show the design cross-sections for the dam and dike, both of which are full hydraulic fill structures. However, no design criteria for embankment stability or calculations are available. Furthermore, there are no construction records available which define soil properties.

A theoretical analysis of the structural stability of the dam and dike embankments was not possible due to lack of pertinent design and construction data. Nevertheless, the downstream slopes of 2 horizontal to 1 vertical above El. 499 and 2.5 to 1 below that grade, are considered reasonable for a hydraulic fill embankment of this height.

C. Operating Records. Records of crest settlement are available from surveys on settlement pins located at the top of light riprap on the upstream slope. The results of settlement observations have been discussed in Section III and are shown on figures in Appendix B-69 and B-70.

Generally, crest settlements are reasonable, in particular the time-settlement relationship of one point to another, and do not suggest any embankment instability. However, the settlement at Sta. 17 at Goodnough Dike, from 1952 to 1973, was about 0.1 ft. greater than would be expected. This result may be due to a survey error or to a local movement of the monument. While it does not suggest embankment instability in this area, it should be checked.

D. Post-Construction Changes. It is understood that there have been no significant post-construction changes to the dam and dike embankments. To accommodate differential settlement, some reconstruction, including repaving and pointing, has been undertaken where the Winsor Dam embankment interfaces with the intake structure.

E. Seismic Stability. The Quabbin Reservoir projects are located in Seismic Zone 2. According to C. of E. guidelines, projects in this zone are "assumed to present no hazard from earthquake provided static stability conditions are satisfied and conventional safety margins exist." At the present time, it is not known whether conventional safety factors exist for static stability analyses.

Because of the importance of these structures for water supply to the Greater Boston area, because of the high hazard potential in the event of a failure, and because the embankments are hydraulic fill with relatively steep slopes, a detailed investigation of embankment stability under static and earthquake loading is recommended.

6.2 EVALUATION OF STRUCTURAL STABILITY, QUABBIN SPILLWAY

A. Visual Observations. No visual evidence was noted that would indicate a structural stability problem with the masonry spillway. One small pressure leak was observed during the inspection which should be attended to to minimize the uplift force on the weir.

B. Design and Construction Data. Design data in the form of record drawings for the spillway and construction data in the form of construction photographs are available. Utilizing these data, a stability check was performed on the spillway weir, and the structural design was found to be adequate for the PMF.

C. Operation Records. Operation records in the form of water surface elevation since the time of construction are available.

D. Post-Construction Changes. A comparison of the visual appearance of the spillway weir and the record drawings indicate that no major modifications have been made to the spillway.

E. Seismic Stability. The spillway weir is deemed adequate for seismic stability in that it is located in a Zone 2 region and is adequate for normal loadings up to and including a probable maximum flood.

VII. ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 ASSESSMENT

A. Condition. The visual examination of Winsor Dam, Quabbin Spillway and Goodnough Dike, and review of available documents, did not reveal any evidence of failure or conditions which would warrant urgent remedial treatment. The projects are well maintained and are in excellent to good condition.

The Quabbin Spillway and auxiliary spillway at Winsor Dam are adequate to safely pass the test flood, estimated to be 16,300 cfs, without overtopping the dam. The estimated maximum discharge since the project was completed 40 years ago, was 1600 cfs in April 1953.

B. Adequacy of Information. Generally, available drawings and other information were adequate for this Phase I Investigation. However, there is insufficient information to evaluate embankment stability under static loads and forces due to earthquakes.

C. Urgency. The recommendations for additional investigations and remedial measures outlined in Sections 7.2 and 7.3, respectively, should be undertaken by the MDC within 24 months after receipt of this Phase I Inspection Report.

D. Need for Additional Investigation. Additional investigations should be performed by the Owner as outlined in Section 7.2.

7.2 RECOMMENDATIONS

1. An investigation to assess the stability of the downstream slopes for both Winsor Dam and Goodnough Dike, under static and earthquake loading. The assessment should include the potential for a failure and/or excessive movement during a seismic event. To perform the required analyses, test borings and detailed laboratory testing will be required to provide data.
2. A new level survey on seven settlement observation points at Goodnough Dike, in particular to check the 1973 data at

Sta. 17. If the survey indicates a continued rate of settlement greater than at adjacent pins, consideration should be given to expanding the study to investigate the cause of greater subsidence and the area affects.

7.3 REMEDIAL MEASURES

A. Alternatives. Not applicable.

B. Operating and Maintenance Procedures. The following remedial work should be undertaken by the MDC to correct deficiencies noted during the visual examination:

1. Repair the lining of the former diversion tunnel at Winsor Dam. While the cracks and leakage in this tunnel pose no threat to the dam itself, a collapse of the tunnel roof could cause the rupture of an outlet conduit and reduce the control capabilities of the reservoir level.
2. Repoint the Quabbin Spillway weir masonry to maintain the structure in good condition.
3. Periodically remove brush, saplings and rockfalls from the spillway discharge pool and discharge channel.
4. Due to the size of the project and the "high" hazard potential classification, the MDC should develop a formal emergency preparedness plan and warning system, in cooperation with local officials in communities downstream of the project.
5. Make periodic visual observations of wet areas downstream of Goodnough Diike, noting carefully the extent of the wet area, evidence of active seepage into the area and related information for correlation with rainfall, snowmelt, reservoir level, etc. The objective of this activity will be to determine whether the wet areas are related to reservoir stage or are merely surface manifestations of seasonal effects of rainfall, etc.

6. Repoint the lower courses of the Intake Structure stone masonry exterior walls.

7. Fill animal burrow holes on upper berm of Winsor Dam near right abutement.

APPENDIX A
INSPECTION TEAM ORGANIZATION AND CHECK LIST

	<u>Page No.</u>
<u>VISUAL INSPECTION PARTY ORGANIZATION</u>	1
<u>VISUAL INSPECTION CHECK LIST</u>	
Winsor Dam Embankment	2
Outlet Works - Control Building	3
Outlet Works - Conduit	3
Outlet Works - Outlet Structure (Power House) and Outlet Channel	4
Auxiliary Spillway at Winsor Dam	4
Quabbin Spillway - Spillway Weir, Approach and Discharge Channels	6
Goodnough Dike Embankment	8

VISUAL INSPECTION PARTY ORGANIZATION

NATIONAL DAM INSPECTION PROGRAM

Dam: Quabbin Reservoir: Winsor Dam, Quabbin Spillway
and Goodnough Dike

Date: 29 June 1978

Time: 8:30 a.m. to 5:00 p.m.

Weather: Clear to partly cloudy, hot

Water Surface Elevation Upstream: El. 529.73 (B. C. B. Datum)

Stream Flow: Not applicable

Inspection Party:

Harl P. Aldrich, Jr.	- Soils
Haley & Aldrich, Inc.	
Allen W. Hatheway	- Geology
Haley & Aldrich, Inc.	
Roger H. Wood	- Structural
Camp, Dresser & McKee, Inc.	
Charles E. Fuller	- Hydraulic/Hydrologic
Camp, Dresser & McKee, Inc.	
Charles Loveridge	- Mechanical/Electrical
Camp, Dresser & McKee, Inc.	

Present During Inspection:

Harold E. Mellin, Jr., M.D. C.
David Ashendon, M.D. C.
Harold Willey, M.D. C.

VISUAL INSPECTION CHECK LIST **NATIONAL DAM INSPECTION PROGRAM**

DAM: Quabbin Reservoir: Winsor Dam **DATE:** 29 June 78

AREA EVALUATED	CONDITION
<u>WINSOR DAM EMBANKMENT</u>	
Crest Elevation	Originally, approximately El. 551 to El. 553 to allow for settlement
Current Pool Elevation	El. 529.73 (B. C. B. Datum)
Maximum Impoundment to Date	El. 531.03 on April 18, 1953
Surface Cracks	None observed
Pavement Condition	Very good; minor random transverse cracks in asphalt concrete
Movement or Settlement of Crest	None observed (see text for crest settlement data)
Lateral Movement	None observed
Vertical Alignment	Excellent
Horizontal Alignment	Excellent
Condition at Abutment and at Concrete Structures	Approximately 6 to 8 in. of embankment settlement adjacent to intake structure is visible
Indications of Movement of Structural Items on Slopes	No structural items on slopes. However, stone wall adjacent to intake structure has moved laterally and has settled (see photographs)
Trespassing on Slopes	Frequent, no restrictions on downstream grass slope
Animal Burrows in Embankment	Several noted on upper berm near right abutment
Vegetation on Embankment	Grass in good condition, mowed recently
Sloughing or Erosion of Slopes or Abutments	None observed of any significance
Rock Slope Protection - Riprap Failures	Light dumped riprap on upstream slope above berm, heavy riprap below berm; irregular but in good condition; no failures observed
Unusual Movement or Cracking at or near Toes	None observed
Unusual Embankment or Downstream Seepage	None observed
Piping or Boils	None observed
Foundation Drainage Features	None

FILE NO. 4150

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

APPENDIX A-2

VISUAL INSPECTION CHECK LIST **NATIONAL DAM INSPECTION PROGRAM**

DAM: Quabbin Reservoir: Winsor Dam **DATE:** 29 June 78

AREA EVALUATED	CONDITION
<p>Toe Drains Instrumentation Systems</p> <p><u>OUTLET WORKS - CONTROL BUILDING</u></p> <p><u>a. Concrete and Structural</u></p> <p>General Condition Condition of Joints</p> <p>Spalling Visible Reinforcing Rusting or Staining Any Seepage or Efflorescence Joint Alignment Unusual Seepage or Leaks in Gate Chamber Cracks</p> <p><u>b. Mechanical and Electrical</u></p> <p><u>OUTLET WORKS - CONDUIT</u></p> <p>General Condition</p>	<p>None</p> <p>Eight "pins" for measuring settlement of crest of dam (see text)</p> <p>Two abandoned (lost) observation wells</p> <p>Good to excellent</p> <p>Some mortar missing in exterior joints at riprap level</p> <p>None noted</p> <p>None noted</p> <p>Incidental rust on interior steel columns</p> <p>Efflorescence at bottom courses of block</p> <p>Good</p> <p>Not observable</p> <p>No major cracks noted</p> <p>Equipment reported to be in operable condition, no apparent deficiencies observed</p> <p>Mainly not observable, underground; top of 68-in. conduit exposed in former stream diversion tunnel; tunnel not illuminated</p> <p>Former stream diversion tunnel lining contains numerous cracks; moderate leak in roof of tunnel 450 ft. from power house at apparently old patch and cracks.</p>

FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

APPENDIX A-3

VISUAL INSPECTION CHECK LIST **NATIONAL DAM INSPECTION PROGRAM**

DAM: Quabbin Reservoir: Winsor Dam DATE: 29 June 78

AREA EVALUATED	CONDITION
<u>OUTLET WORKS - OUTLET STRUCTURE (POWER HOUSE) AND OUTLET CHANNEL</u>	
a. <u>General Condition of Concrete and Masonry</u>	<p>Good condition</p>
<p>Rust or Staining</p> <p>Spalling</p> <p>Visible Reinforcing</p> <p>Any Seepage or Efflorescence</p>	<p>Underside of roof stained</p> <p>Shrinkage cracks in bond beam below roof</p> <p>None observed</p> <p>Efflorescence present lower portion of walls lower floor. Water on floor from unknown source</p>
<p>Condition at Joints</p>	<p>Good</p>
b. <u>Electrical-Mechanical</u>	<p>Equipment reported to be in operable condition - no apparent deficiencies observed. Reported cavitation, problem with control valves corrected by orifice plates</p>
c. <u>Channel</u>	
<p>Loose Rock or Trees</p> <p>Overhanging Channel</p> <p>Condition of Discharge Channel</p>	<p>A few trees overhanging channel</p> <p>Good - riprap</p>
<u>AUXILIARY SPILLWAY AT WINSOR DAM</u>	
a. <u>Channel Upstream of Weir</u>	
<p>General Condition</p> <p>Floor of Channel</p>	<p>Excellent</p> <p>Flat, covered with grass mowed recently; three trees; some brush at entrance to channel; gravel road crossing channel floor just upstream of weir creates minor obstruction to flow</p>

DAM: Quabbin Reservoir: Winsor Dam DATE: 29 June 78

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

VISUAL INSPECTION CHECK LIST **NATIONAL DAM INSPECTION PROGRAM**

DAM: Quabbin Reservoir: Quabbin Spillway **DATE:** 29 June 78

AREA EVALUATED	CONDITION
<u>QUABBIN SPILLWAY - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS</u>	
<u>a. Approach Channel</u>	
General Condition	Good
Loose Rock Overhanging Channel	None of any significance observed
Trees Overhanging Channel	A few small trees overhanging channel, but not significant
Floor of Approach Channel	Not observable
<u>b. Weir and Training Walls</u>	
General Condition of Masonry Joints	Good; several spots of vegetation in upper joint; some mortar missing especially in lower portion; bottom joint eroded
Rust or Staining Cracks	None observed Vertical cracks at each end and center of highest portion of weir
Any Visible Reinforcing	None observed
Any Seepage or Efflorescence	Seepage observed at highest joint; trace of moisture along bottom of high portion; seepage at end of high weir portion where it abuts rock; efflorescence present in high portion of weir - at junction with rock, mid-height and lower portions of weir
Drain Holes	None observed
<u>c. Service Bridge</u>	
General Condition	Good
Walkway	Good condition
Guides	Excellent condition
Flashboards	Good condition

FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

APPENDIX A-6

VISUAL INSPECTION CHECK LIST NATIONAL DAM INSPECTION PROGRAM

DAM: Quabbin Reservoir: Quabbin Spillway **DATE:** 29 June 78

AREA EVALUATED	CONDITION
<p><u>d. Discharge Channel</u></p> <p>General Condition</p> <p>Loose Rock Overhanging Channel</p> <p>Trees Overhanging Channel</p> <p>Floor of Channel</p> <p>Other Obstructions</p>	<p>Good</p> <p>Evidence of prior rock falls from left face (see text)</p> <p>Young trees at top of rock walls; few in channel but not significant</p> <p>Irregular bedrock surface; some blocks of rock from rock cuts, especially at entrance to channel</p> <p>Some brush growth</p>

FILE NO. 4100

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

APPENDIX A-7

VISUAL INSPECTION CHECK LIST **NATIONAL DAM INSPECTION PROGRAM**

DAM: Quabbin Reservoir: Goodnough Dike DATE: 29 June 78

AREA EVALUATED	CONDITION
<u>GOODNOUGH DIKE</u> <u>EMBANKMENT</u>	
Crest Elevation	Originally, approximately El. 551 to El. 553 to allow for settlement
Current Pool Elevation	El. 529.73 (B. C. B. Datum)
Maximum Impoundment to Date	El. 531.03 on April 18, 1953
Surface Cracks	None observed
Pavement Condition	Excellent; a few minor random transverse cracks in asphalt concrete
Movement or Settlement of Crest	None observed (See text for crest settlement data)
Lateral Movement	None observed
Vertical Alignment	Excellent
Horizontal Alignment	Excellent
Condition at Abutment and at Concrete Structures	Good (no concrete structures); dike abuts rock at both ends
Indications of Movement of Structural Items on Slopes	No structural items on slopes
Trespassing on Slopes	Frequent, no restrictions on downstream grass slope
Animal Burrows in Embankment	None observed
Vegetation on Embankment	Grass in good condition, a few small bare areas; grass mowed recently
Sloughing or Erosion of Slopes or Abutments	None observed of any significance
Rock Slope Protection - Riprap Failures	Light dumped riprap on upstream slope above berm, heavy riprap below berm; irregular but in good condition; no failures observed
Unusual Movement or Cracking at or near Toes	None observed
Unusual Embankment or Downstream Seepage	Two unmowed areas at downstream toe of embankment; water clear; no flow observed (See photos)
Piping or Boils	None observed
Foundation Drainage Features	None

FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

APPENDIX A-8

VISUAL INSPECTION CHECK LIST **NATIONAL DAM INSPECTION PROGRAM**

DAM: Quabbin Reservoir: Goodnough Dike DATE: 29 June 78

AREA EVALUATED	CONDITION
<p>Toe Drains Instrumentation Systems</p>	<p>None Seven "pins" for measuring settlement of crest of dike (See text) One abandoned (lost) observation well</p>

FILE NO. 4160

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

APPENDIX A-9

APPENDIX B
LIST OF AVAILABLE DOCUMENTS AND
PRIOR INSPECTION REPORTS

Page No.

LIST OF AVAILABLE DOCUMENTS

Winsor Dam	1
Quabbin Spillway	3
Goodnough Dike	4
Quabbin Reservoir Contracts	5

PRIOR INSPECTION REPORTS

Winsor Dam

<u>Date</u>	<u>By</u>	
Undated	Unknown	6
26 February 1974	Mass. Department of Public Works	7
23 March 1976	Mass. Department of Environmental Quality Engineering	21

Quabbin Spillway

<u>Date</u>	<u>By</u>	
Undated	Unknown	25
26 February 1974	Mass. Department of Public Works	26
23 March 1976	Mass. Department of Environmental Quality Engineering	37

Goodnough Dike

<u>Date</u>	<u>By</u>	
Undated	Unknown	43
26 February 1974	Mass. Department of Public Works	44

DRAWINGSPage No.

<u>Sheet</u>	<u>Acc.</u>		
2	24102	Main Dam Embankment General Plan	54
11	4311	Main Dam Core Wall Overburden - Geological Data - Sheet 1	55
12	4311	Main Dam Core Wall Overburden - Geological Data - Sheet 2	56
13	4311	Main Dam Core Wall Overburden Geological Data - Sheet 3	57
4	24104	Main Dam Embankment Profile on Centerline of Main Dam	58
10	24110	Main Dam Embankment Cross Section of Top of Main Dam	59
17	24117	Main Dam Embankment Intake Works - Intakes	60
16	24116	Main Dam Embankment Auxiliary Spillway	61
11	24111	Main Dam Embankment Spillway Channel - Sheet 1	62
12	24112	Main Dam Embankment Spillway Channel - Sheet 2	63
2	23402	Dike Embankment General Plan	64
8	3908	Dike Core Wall Overburden - Geological Data - Sheet 1	65
9	3909	Dike Core Wall Overburden - Geological Data - Sheet 2	66
4	23404	Dike Embankment Profile on Center Line of Dike	67
3	23403	Dike Embankment Typical Cross Sections	68
	17792	Winsor Dam Embankment Settle- ment of the Embankment	69
	17641	Dike Embankment Settlement of the Embankment	70

LIST OF AVAILABLE DOCUMENTS
WINSOR DAM

<u>DOCUMENT</u>	<u>CONTENTS</u>	<u>LOCATION</u>
"Construction of Core Wall at Main Dam", MDC Contract No. 38, Sheet 11, Acc. 4311, 21 December 1934	Overburden and geological data from borings, test pits and exploratory caissons shown on profiles	MDC, 20 Somerset St., Boston, MA (Appendix B-55)
"Construction of Core Wall at Main Dam", MDC Contract No. 38, Sheet 12, Acc. 4312, 21 December 1934	Overburden and geological data from borings and test pits shown on profiles	MDC, 20 Somerset St., Boston, MA (Appendix B-56)
"Construction of Core Wall at Main Dam", MDC Contract No. 38, Sheet 13, Acc. 4313, 21 December 1934	Overburden and geological data from the three exploratory caissons	MDC, 20 Somerset St., Boston, MA (Appendix B-57)
"Main Dam Embankment", MDC Contract No. 52, Sheet 2, Acc. 24102, 1 June 1936	General plan	MDC, 20 Somerset St., Boston, MA (Appendix B-54)
"Main Dam Embankment", MDC Contract No. 52, Sheet 4, Acc. 24104, 1 June 1936	Profile on centerline of dam	MDC, 20 Somerset St., Boston, MA (Appendix B-58)
"Main Dam Embankment", MDC Contract No. 52, Sheet 10, Acc. 24110, 1 June 1936	Cross-section of top of dam	MDC, 20 Somerset St., Boston, MA (Appendix B-59)

<u>DOCUMENT</u>	<u>CONTENTS</u>	<u>LOCATION</u>
"Main Dam Embankment", MDC Contract No. 52, Sheet 17, Acc. 24117, 1 June 1936	Plan and sections of intake works	MDC, 20 Somerset St., Boston, MA (Appendix B-60)
"Main Dam Embankment", MDC Contract No. 52, Sheet 16, Acc. 24116, 1 June 1936	Plan, profile and sections of auxiliary spillway	MDC, 20 Somerset St., Boston, MA (Appendix B-61)
"Winsor Dam Embankment Settlement", MDC Acc. 17792, 28 October 1940	Settlements of embankment and roadway from 7 July 1939 to 26 June 1973	MDC, 20 Somerset St., Boston, MA (Appendix B-69)

LIST OF AVAILABLE DOCUMENTS
QUABBIN SPILLWAY

<u>DOCUMENT</u>	<u>CONTENTS</u>	<u>LOCATION</u>
"Main Dam Embankment", MDC Contract No. 52, Sheet 2, Acc. 24102, 1 June 1936	General plan showing spillway and Winsor Dam	MDC, 20 Somerset St., Boston, MA (Appendix B-54)
"Main Dam Embankment", MDC Contract No. 52, Sheet 11, Acc. 24111, 1 June 1936	Plan and profile at spillway channel	MDC, 20 Somerset St., Boston, MA (Appendix B-62)
"Main Dam Embankment", MDC Contract No. 52, Sheet 12, Acc. 24112, 1 June 1936	Selected cross-sections through spillway channel	MDC, 20 Somerset St., Boston, MA (Appendix B-63)

LIST OF AVAILABLE DOCUMENTS
GOODNOUGH DIKE

<u>DOCUMENT</u>	<u>CONTENTS</u>	<u>LOCATION</u>
"Construction of Core Wall at Dike", MDC Contract No. 36, Sheet 8, Acc. 3908, 4 November 1932	Overburden and geological data from borings, test pits and the exploratory caisson shown on profiles	MDC, 20 Somerset St., Boston, MA (Appendix B-65)
Construction of Core Wall at Dike", MDC Contract No. 36, Sheet 9, Acc. 3909, 4 November 1932	Overburden and geological data from borings and test pits shown on profiles	MDC, 20 Somerset St., Boston, MA (Appendix B-66)
"Embankment of Dike", MDC Contract No. 50, Sheet 2, Acc. 23402, 1 October 1934	General plan	MDC, 20 Somerset St., Boston, MA (Appendix B-64)
"Embankment of Dike", MDC Contract No. 50, Sheet 4, Acc. 23404, 1 October 1934	Profile on centerline of dike	MDC, 20 Somerset St., Boston, MA (Appendix B-67)
"Embankment of Dike", MDC Contract No. 50, Sheet 3, Acc. 23403, 1 October 1934	Typical cross-sections	MDC, 20 Somerset St., Boston, MA (Appendix B-68)
"Dike Embankment, Settlement of the Embankment", MDC Acc. 17641, 10 October 1939	Settlements of embankment and roadway from 8 December 1936 to 27 June 1973	MDC, 20 Somerset St., Boston, MA (Appendix B-70)

**LIST OF AVAILABLE DOCUMENTS
QUABBIN RESERVOIR CONTRACTS**

The following list is intended as a guide to obtaining additional documents on Winsor Dam, Quabbin Spillway and Goodnough Dike available at the MDC, 20 Somerset St., Boston, MA

Contract No.

2	Borings Swift Dam Site
3	Air Photos, Swift Valley
23	Borings - Belchertown, Enfield, Ware
30	Stream Control Works at Main Dam
32	Constructing Exploratory Caissons
36	Constructing Core Wall at Dike
38	Construction Core Wall at Winsor Dam
45	Explor. by Shovel Cuts - Main Dam and Dike
50	Embankment at Dike
52	Main Dam Embankment
118	Misc. Construction at Winsor Dam and Dike
119	Pylons at Winsor Dam
148	Sale of Power - Winsor Dam
149A	Hydraulic Turbine - Winsor Dam
149B	Generator - Winsor Dam
149C	Switchgear, Bus Reactor, Metering Outfit, Control Panel - Winsor Dam
149D	Transformer - Winsor Dam
149E	Substation - Winsor Dam
149F	Storage Battery and Charging Equipment - Winsor Dam
150	Installation of Power Plant

WINSOR DAM

C. Quabbin Dike, Winsor Dam and Spillway

The grass cover on the embankment forming the dike was noted to be o. k. The toe area of the dry side was in good condition and dry. The road on top of the embankment was in good condition and there was no evidence of settlement, sunken areas or cracks. The rock fill slope on the reservoir side of the dike is in good condition. Water in storage was observed to be quite low but appeared to be higher in elevation than at the time of the previous inspection.

The main dam, Winsor Dam, was noted to be in good condition. The turf cover on the downstream slope was good. Some areas apparently are being re-loamed, treated and seeded. The toe area of this main dam was dry.

The rock filled portion of the main dam on the reservoir side was in good condition. The road across the dam was o. k.

The spillway structure was again observed to be completely dry. The spillway has not been wet for many years. However, the level of water observed this year is at the entrance to the spillway forebay and thus is the highest noted in many years. The stone masonry of the spillway and the crest were observed to be o. k.

In the opinion of the undersigned, the dam, the dike and spillway are in the same good condition as previously reported, and are safe.

OK
Feb 6

INSPECTION REPORT - DAMS AND RESERVOIRS

1. LOCATION:
- City/Town Ware County Hampshire Dam No. 2-8-309-1A
- Name of Dam Quabbin "Winsor" Dam
- Mass. Sect.
- Topo Sheet No. 14D Coordinates: N 469,000 E 373,500
- Inspected by: R. C. Sells, P.E. On Feb. 26, 1974 Date Last Inspection 1970
- See also Quabbin Spillway No. 2-8-309-1B & Goodnough Dike No. 2-8-309-1C
2. OWNER/S: As of November 1972
- per: Assessors X, Reg. of Deeds , Prev. Insp. , Per. Contact X
1. Metropolitan District Commission, Winsor Dam - Ware Rd., Belchertown, Mass.
- | | | | | |
|------|-----------|-----------|-------|----------|
| Name | St. & No. | City/Town | State | Tel. No. |
| | | | | |
2.
- | | | | | |
|------|-----------|-----------|-------|----------|
| Name | St. & No. | City/Town | State | Tel. No. |
| | | | | |
3.
- | | | | | |
|------|-----------|-----------|-------|----------|
| Name | St. & No. | City/Town | State | Tel. No. |
| | | | | |
3. CARETAKER: (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.
- Mr. John W. Copithorne, Supt.
- Quabbin Reservoir, M.D.C. Winsor Dam, Ware Rd., Belchertown, Mass. 013-327-6021
- | | | | | |
|------|-----------|-----------|-------|----------|
| Name | St. & No. | City/Town | State | Tel. No. |
| | | | | |
4. DATA:
- No. of Pictures Taken None Sketches See description of Dam.
- Plans, Where In M.D.C. office at Quabbin
5. DEGREE OF HAZARD: (if dam should fail completely)*
1. Minor 3. Severe
2. Moderate 4. Disastrous X
- Comments: Assuming complete failure
- This rating may change as land use changes (future development).

Intake structure at southwesterly end of dam for 48" diam. and 68" diam. conduits in outlet tunnel

Automatic . Manual X . Operative Yes X , No .

No. 2 Location and Type: See Quabbin Spillway - Dam No. 2-8-300-12

Automatic . Manual X . Operative Yes X , No .

No. 3 Location and Type: Auxiliary spillway 1200 ft. southwesterly of end of dam.

Automatic . Manual . Operative Yes , No .

Comments: Crest of auxiliary spillway 6 ft. above reservoir flow line
or about 17 ft. below top embankment

Drawdown present Yes X, No , Operative Yes X, No .

Comments: See No. 1 above - lower intake

Material: Turf____. Brush & Trees____. Rock fill____X____. Masonry____. Wood____.
10' thick

Other 3 berms on slope

Condition: 1. Good X

3. Major Repairs_____

2. Floor Repairs

4. Urgent Repairs

Comments: For details of slope see sketches - sheet #2

Material: Turf 1 . Bush & Trees . Rock Fill . Masonry . Wood .

Other 2 berms on slope. Slope drainage installed

Condition: 1. Good 1

3. Major Repairs_____

2. Minor Repairs_____

4. Urgent Repairs_____

Comments: Access road to powerhouse; outlet structure and beginning of
Chicopee aqueduct crosses slope

6. OUTLETS: OUTLET CONTROLS AND DRAWDOWN

No. 1 Location and Type: Quabbin Aqueduct at N500,700, EY89,500

Controls Yes, TYPE: In District 3 - Worcester County

Automatic Manual Operative Yes X, No

Comments: Aqueduct to Wachusett Reservoir and to Boston

No. 2 Location and Type:

Controls Type:

Automatic Manual Operative Yes, No

Comments:

No. 3 Location and Type:

Controls Type:

Automatic Manual Operative Yes, No

Comments:

Drawdown present Yes, No Operative Yes, No

Comments:

7. DAM UPSTREAM FACE: Slope, Depth Water at Dam

Material: Turf Brush & Trees Rock fill Masonry Wood

Other

Condition: 1. Good 3. Major Repairs

2. Minor Repairs 4. Urgent Repairs

Comments:

8. DAM DOWNSTREAM FACE: Slope

Material: Turf Brush & Trees Rock Fill Masonry Wood

Other

Condition: 1. Good 3. Major Repairs

2. Minor Repairs 4. Urgent Repairs

Comments:

9. EMERGENCY SPILLWAY: Available Yes, Needed No.

Height Above Normal Water 6 Ft. auxiliary spillway
 Width 200 Ft. Height 3.4 Ft. Material Earth channel
Masonry weir
 Condition: 1. Good X 3. Major Repairs _____
 2. Minor Repairs _____ 4. Urgent Repairs _____

Comments: See sheet 6 of sketches - Note: See also Quabbin spillway,
Dam No. 2-8-309-1B

10. WATER LEVEL AT TIME OF INSPECTION: 75 Ft. Above _____ Below _____

Top Dam X P.L. Principal Spillway _____
 Other _____
 Normal Freeboard 23 Ft.

11. SUMMARY OF DEFICIENCIES NOTED:

Growth (Trees and Brush) on Embankment None
 Animal Burrows and Washouts None seen
 Damage to Slopes or Top of Dam None. Note precise levels in 1970 show
embankment has settled 1.50 ft.
 Cracked or Damaged Masonry None seen
 Evidence of Seepage Minor seepage - handled by drainage system
 Evidence of Piping None seen
 Leaks None seen
 Erosion None noted
 Trash and/or Debris Impeding Flow None
 Clogged or Blocked Spillway No. - Note automatic screening equipment being
installed at time of inspection.
 Other _____

(12)

OVERALL CONDITION:

1. Safe X
2. Minor repairs needed _____
3. Conditionally safe - major repairs needed _____
4. Unsafe _____
5. Reservoir impoundment no longer exists (explain)
Recommend removal from inspection list _____

(13)

REMARKS AND RECOMMENDATIONS: (Fully Explain)

This dam across the Swift River forms the Quabbin Reservoir. It is an earth embankment 2600 feet long and over 155 feet high. There is a concrete caisson core wall with its top somewhere near the original ground line which extends to bedrock located on the centerline of the embankment. The earth embankment is a full hydraulic fill structure with a riprap shell on the upstream face and with a loam and turf surface on the downstream slope.

An examination of the embankment, the intake structure, and the outlet structure or powerhouse found no visible defects. The examination included viewing the interior of the outlet tunnel and viewing the interior of one of the intake structure wells in an unwatered condition. At the time of the inspection automatic screening devices were being installed in the intake wells and as a part of this work the bearing brackets for the gate operating shafts were being rehabilitated.

Core drillings of the concrete in the interior of the intake wall obtained from the drilling of anchor bolt holes for the installation of the screening device showed the concrete to be in excellent condition.

The two observation wells originally installed in this dam are no longer usable and no information on recent observation was available. Precise levels were taken on the top of the dam at frequent intervals until 1957 and again in 1973. These showed a settlement of about 1 1/2 feet in 1973 with about a third of the total settlement occurring between 1957 and 1973, a period when the reservoir was at a relatively low level. This dam was originally designed with a 2 foot camber to allow for settlement.

Mr. Mallin, the Assistant Superintendent, accompanied us on our inspection.

RCS/js/vk

DESCRIPTION OF DAM:

DISTRICT 2

Submitted by E. C. Sells, P.E. Dam No. 2-8-309-1A

Date February 26, 1974 River/Town Ware

Name of Dam Quabbin "Winsor" Dam

See also Dam No. 2-8-309-1B - Quabbin Spillway & No. 2-8-309-1C Goodnough Dike

1. Location: Topo Sheet No. 14D Mass. Rect. Coordinates N 450,000 E 351,500
Provide 8 1/2" x 11" in clear copy of topo map with location of Dam clearly indicated.
Access from Ware Rd. "Rte. 9" about 2 1/2 mi. easterly from Junction with Rte. 21 -
About 2500 ft. (1/4 mile) northerly from Rte. 9 on Winsor Dam Rd. - road goes over dam
2. Year built 1936 - 38 Year/s of subsequent repairs 1970
3. Purpose of Dam: Water Supply I Recreational _____
Flood Control _____ Irrigation _____ Other _____
4. Drainage Area: 186 sq. mi. plus limited diversion from Ware River watershed of 98 sq. mi.
Type: City, Bus. & Ind. _____ Dense Res. _____ Suburban _____ Rural, Farm 15%
Wood & Scrub Land 85% Slope: Steep 15% Med. 75% Slight 10%
5. Normal Ponding Area: 38.6 sq. mi. Acres; Ave. Depth _____
24,704 Impoundment: 412 billion gals.; Max. water depth 150 ft.
Silted in: Yes _____ No _____ approx. Amount Storage Area Unknown
6. No. and type of dwellings located adjacent to pond or reservoir _____
i.e. summer homes etc. Only residences of operating personnel
7. Dimensions of Dam: Length 2500 ft. Max. Height 155 ft.
Freeboard 23 to top embankment when full
Slopes: Upstream Face Varies 1 1/2 to 1 to 3/4 steep
Downstream Face Varies 2: to 2 3/4:1 turf
Width across top 3 1/4 - paved roadway
See sketches attached.

Dam No. 2-8-309-1A 4

8.

Classification of Dam by Material:

Earth X Conc. Masonry _____ Stone Masonry _____
 Hydraulic fill embankment _____
 Timber _____ Rockfill _____ Other Concrete caisson core wall

8A.

Dam Type: Gravity X Straight r Curved, Arched _____ Other Slight curve
 Embankment _____
 Overflow _____ Non-overflow X at east end

9.

A. Description of present land usage downstream of dam:

90 % rural; 10 % within developed villages of Bondsville & Three Rivers

B. Is there a storage area or flood plain downstream of dam which could accommodate the impoundment in the event of a complete dam failure? Yes _____ No X

C. Character Downstream Valley: Narrow X Wide _____ Developed 10%
 Rural 90% Urban _____

10.

Risk to life and property in event of complete failure. *See note below.

No. of people Say 2 - 300 before Chicopee River

No. of homes 30+ houses before villages of Bondsville & Three Rivers - say 2 - 300
 homes before Chicopee River

No. of businesses Numerous in villages

No. of industries Several light manufacturing plants
 Type _____

No. of utilities 4 Type Water supply - pole lines for telephone & electric plus electrical power plant & transmission lines

Railroads Boston & Maine & Vermont Central R. R.

Other dams Bondsville Upper Dam No. 3-7-227-11 & Bondsville Lower Dam No. 3-7-227-12

Other State Fish Hatchery - numerous town highways and bridges and Route 9 State Highway

11.

Attach sketch of dam to this form showing section and plan on 8 1/2" x 11" sheet.
 Section - 2 sheets

RCS/vk

Attachments

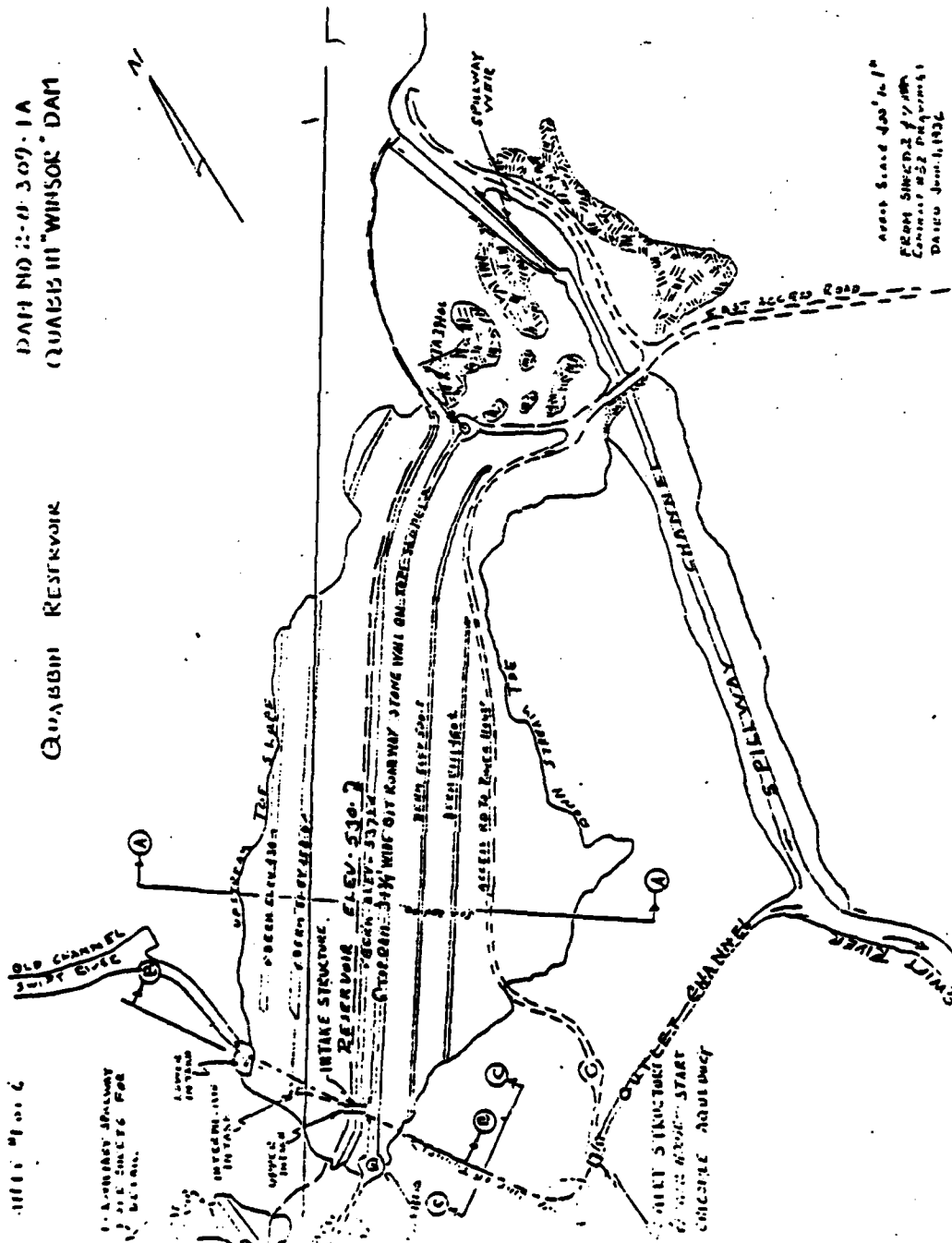
Locus Plan

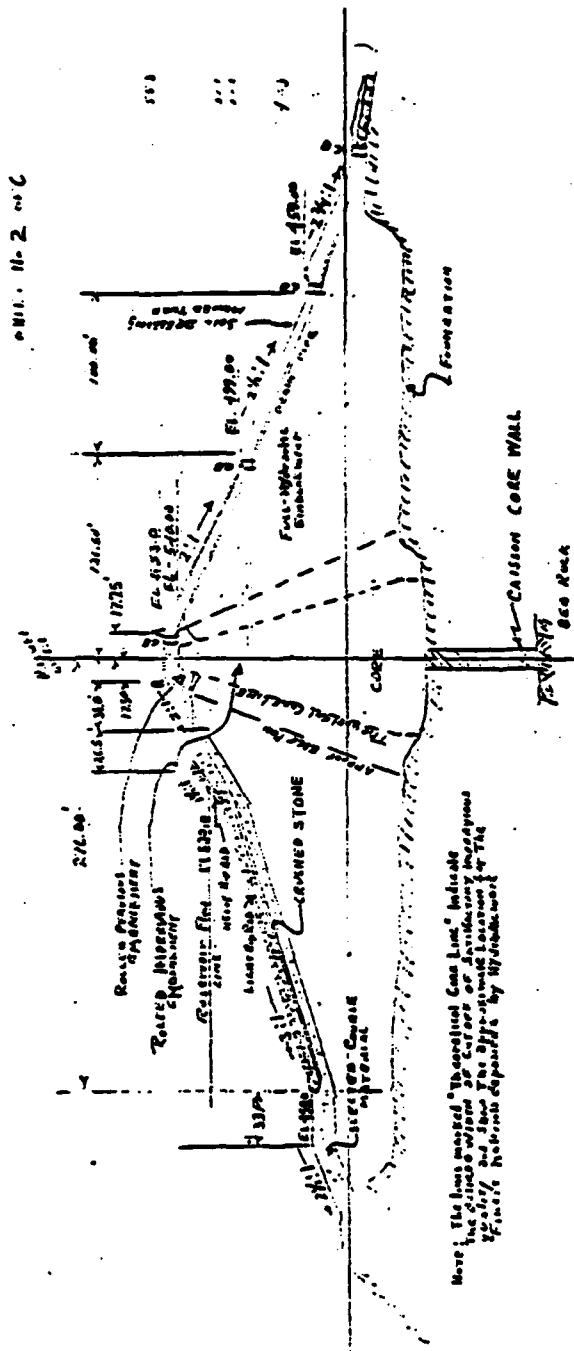
Sketches

* Note: Risk to life and property only along Swift River considered. Damage is likely on Chicopee River, also.

DAM NO 2-0-309-1A
QUANBIN III "WINSOR" DAM

QUANBIN RESERVOIR





"X" SECTION AT STATION 20+00 APPRX. SCALE 1"=40'

X SECTION 'A'

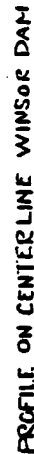
FROM SHEET 3
CONTRACT #52 DRAWING
DATED JUNE 1, 1936

DAM NO 2-8-3091A
QUABBIN "WINSOR" DAM

X SECTION THROUGH INTAKES / STRUT/CONTROL TUNNEL
X SECTION "BB"

FROM SHEET #3
CONTRACT #52
DATED JUNE 1, 1936

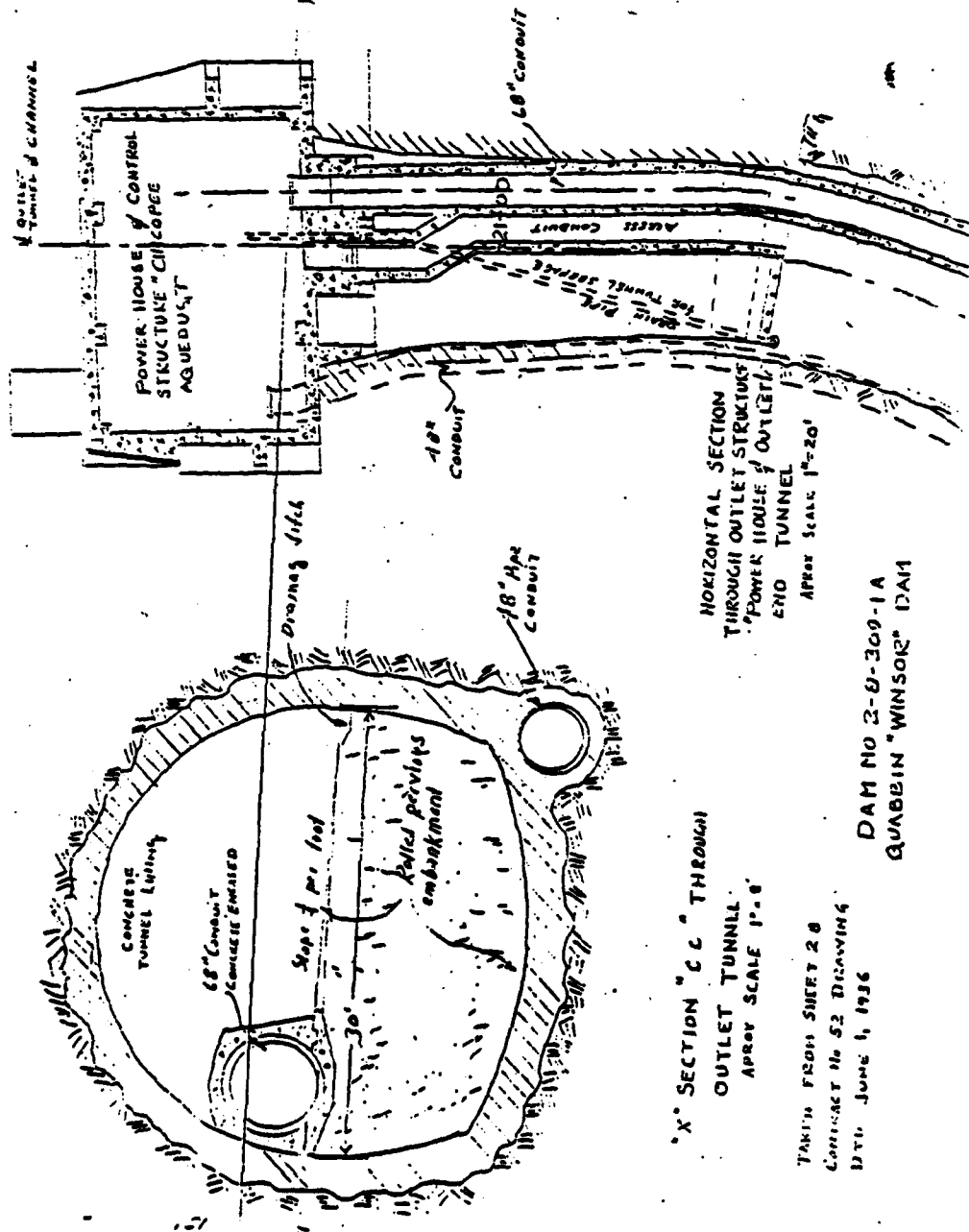
DAM NO 2-7-309-1 AM
QUABBIN "WINSOR" DAM



FROM SNRET 4.
CONTRACT NO 62
DATED JUNE 1, 1936

DAM NO2-B-309-1A
Q UABEIN "WINSOK" DAM

SHEET 5 OF 6



"X" SECTION "C-C" THROUGH
OUTLET TUNNEL
APPROX SCALE 1"=8'

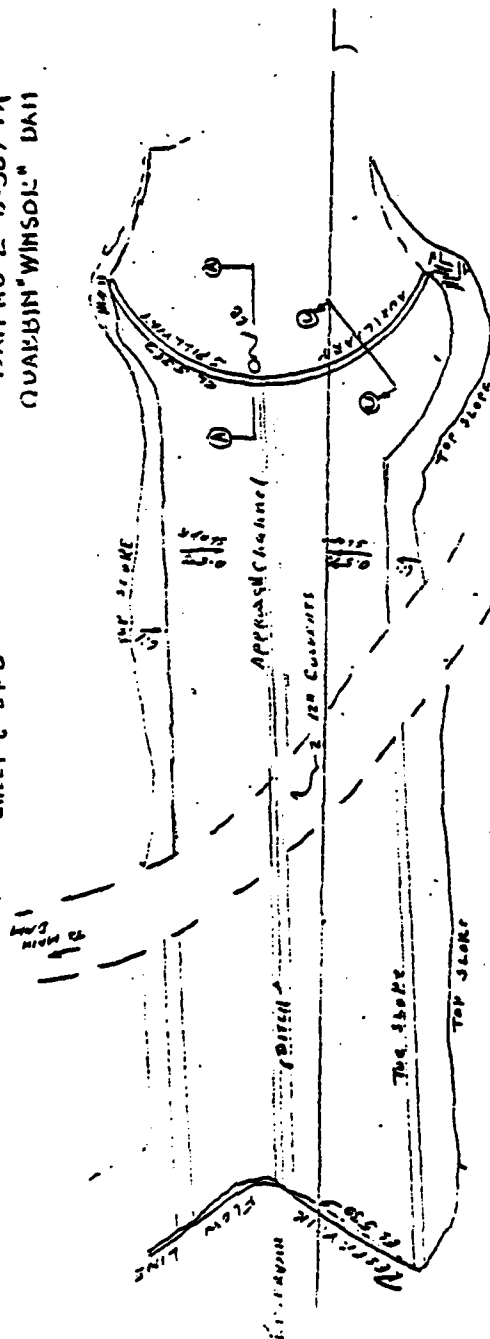
TAKEN FROM SHEET 28
CONTACT NO. 52 DRAWING
DATE: JUNE 1, 1936

HORIZONTAL SECTION
THROUGH OUTLET STRUCTURE
"POWER HOUSE & OUTLET"
END TUNNEL
APPROX SCALE 1"=20'

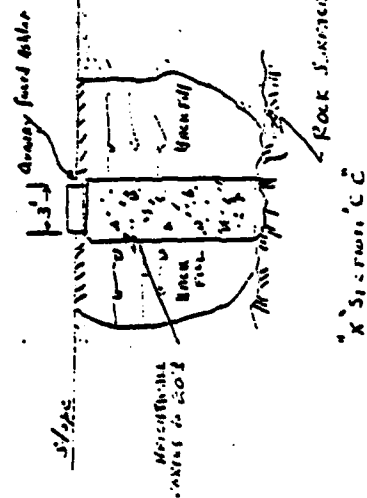
DAM NO 2-0-300-1A
QUABBIN "WINSOR" DAM

DAH NO 2-13-309-1A
QUARBIN WINSOLE" DASH

SHEET C OF C



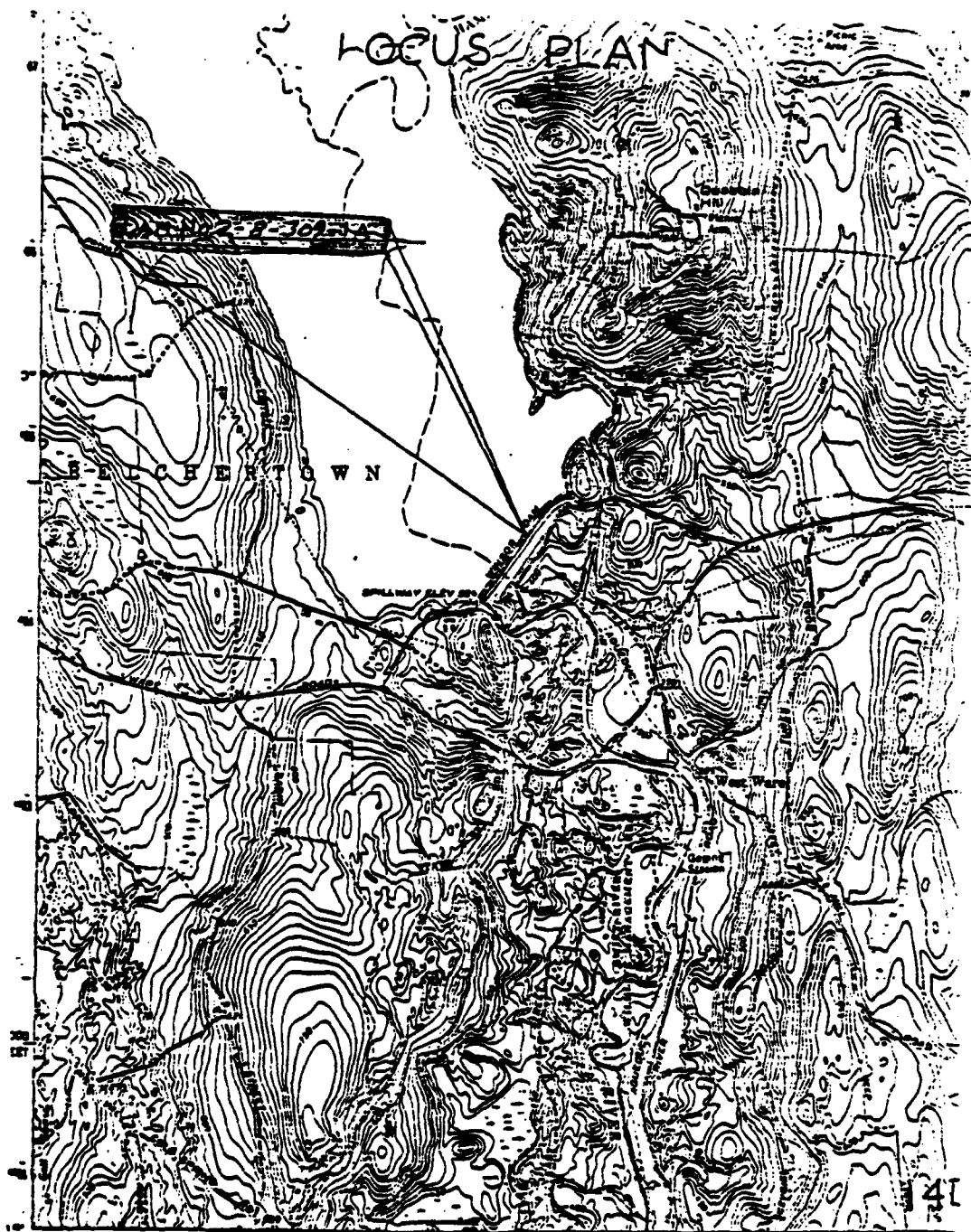
PLAN



FROM CONCRETE 1152 PL. 1000
SHEET 11
SKETCHES OF AUXILIARY
STRUCTURES FOR DASH NO 2-13-309-1A

X SECTION AA

X SECTION CC



C. H. Egan

INSPECTION REPORT - DAMS AND RESERVOIRS

1. LOCATION:

City/Town Ware County Massachusetts Dam No. 2-8-309-1A

Name of Dam Quabbin "Winsor Dam"

Mass. Rect.

Topo Sheet No. 140 Coordinates: N 469,000 E 371,500

Inspected by: Harold T. Shumway Date On March 23, 1976 Last Inspection 2-26-74

See also Quabbin Spillway No. 2-8-309-1B and Goodnowich Dike No. 2-8-309-1C

2. OWNER/S: As of March 23, 1976

per: Assessors _____ Reg. of Deeds _____ Prev. Insp. X Per. Contact X

1. Metropolitan District Commission, Winsor Dam, Ware Road, Belchertown, Mass.

Name _____ St. & No. _____ City/Town _____ State _____ Tel. No. _____

2. _____

Name _____ St. & No. _____ City/Town _____ State _____ Tel. No. _____

3. _____

Name _____ St. & No. _____ City/Town _____ State _____ Tel. No. _____

3. CARETAKER: (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.

Supt. of Quabbin Reservoir

M. D. C. Winsor Dam, Ware Road, Belchertown, Mass. 413-323-6921

Name _____ St. & No. _____ City/Town _____ State _____ Tel. No. _____

4. DATA:

No. of Pictures Taken None Sketches See description of Dam Plans, Where In M.D.C. office files at Winsor Dam Headquarters

5. DEGREE OF HAZARD: (if dam should fail completely)*

1. Minor _____ 3. Severe _____

2. Moderate _____ 4. Disastrous X

Comments: Assuming complete failure.

This rating may change as land use changes (future development).

⑥

OUTLETS: OUTLET CONTROLS AND DRAINDOWN

South westerly end of dam-intake structure for 48" diameter

No. 1 Location and Type: and 68" diameter conduits in outlet tunnel.Controls Yes, Type: Gate valve and slide valve.Automatic . Manual X. Operative Yes X, No .Comments: All in good condition per H.D.C. personnel.No. 2 Location and Type: See Gumbin Spillway Dam No. 2-8-309-1BControls Yes, Type: Flash boards.Automatic . Manual X. Operative Yes X, No .Comments: Minor seepage in drop wall, see Dam No. 2-8-309-1B report.No. 3 Location and Type: Auxiliary spillway 1200 ft. south westerly of end of dam.Controls No, Type: Automatic . Manual . Operative Yes , No .Crest of auxiliary spillway 6 ft. above reservoir flow line or
Comments: about 17 ft. below top embankment.Drawdown present Yes X, No . Operative Yes X, No .Comments: See No. 1 above-lower intake.

⑦

1 1/2:1 variable

DAM UPSTREAM FACE: Slope to 3:1, Depth Water at Dam 152' ±.Material: Turf . Brush & Trees . Rock fill X. Masonry . Wood .
18' thickOther 3 berms on slopeCondition: 1. Good X. 3. Major Repairs .2. Minor Repairs . 4. Urgent Repairs .Comments: All slopes appeared stable, alignment and grade appeared good.

⑧

DAM DOWNSTREAM FACE: Slope 2:1 to 2 3/4:1.Material: Turf X. Brush & Trees . Rock Fill . Masonry . Wood .Other 2 berms on slope, slope drainage installed.Condition: 1. Good X. 3. Major Repairs .2. Minor Repairs . 4. Urgent Repairs .Comments: Access road to cover house; outlet structures and beginning of Chinese
squandut crosses slope. Slope appeared stable.

9. EMERGENCY SPILLWAY: Available Yes. Needed .

Height Above Normal Water 6 Ft.

Width 200 Ft. Height 3 to 4 Ft. Material Masonry weir
earth channel

Condition: 1. Good X. 3. Major Repairs .
2. Minor Repairs . 4. Urgent Repairs .

Comments: See also Quabbin Spillway Dam No. 2-8-309-1B

10. WATER LEVEL AT TIME OF INSPECTION: 234 Ft. Above . Below X.

Top Dam X P.L. Principal Spillway .

Other

Normal Freeboard 23 Ft.

11. SUMMARY OF DEFICIENCIES NOTED:

Growth (Trees and Brush) on Embankment None found.

Animal Burrows and Washouts None found.

Damage to Slopes or Top of Dam None found. Note: precise levels in 1970 show embankment has settled 14".

Cracked or Damaged Masonry None found.

Evidence of Seepage Minor seepage, handled by drainage system.

Evidence of Piping None found.

Leaks None found.

Erosion None found.

Trash and/or Debris Impeding Flow None.

Clogged or Blocked Spillway

Other

OVERALL CONDITION:

1. Safe X
2. Minor repairs needed _____
3. Conditionally safe - major repairs needed _____
4. Unsafe _____
5. Reservoir impoundment no longer exists (explain)
Recommend removal from inspection list _____

REMARKS AND RECOMMENDATIONS: (Fully Explain)

This is the main dam forming the Quabbin Reservoir. It is an earthen embankment with a concrete caisson core wall. The embankment is 2600 feet long and 155' high. The riprap stone shell on the upstream side appeared stable as did the turfed slope of the downstream side. Some slight seepage was noted but did not appear to be of any hazard to dam. It was not possible on this inspection to view the interior of outlet tunnel or intake wells but all exterior surfaces were checked and appeared good.

HIS/et

QUABBIN SPILLWAY

G. Quabbin Dike, Winsor Dam and Spillway

The grass cover on the embankment forming the dike was noted to be o. k. The toe area of the dry side was in good condition and dry. The road on top of the embankment was in good condition and there was no evidence of settlement, sunken areas or cracks. The rock fill slope on the reservoir side of the dike is in good condition. Water in storage was observed to be quite low but appeared to be higher in elevation than at the time of the previous inspection.

The main dam, Winsor Dam, was noted to be in good condition. The turf cover on the downstream slope was good. Some areas apparently are being re-loamed, treated and seeded. The toe area of this main dam was dry.

The rock filled portion of the main dam on the reservoir side was in good condition. The road across the dam was o. k.

The spillway structure was again observed to be completely dry. The spillway has not been wet for many years. However, the level of water observed this year is at the entrance to the spillway forebay and thus is the highest noted in many years. The stone masonry of the spillway and the crest were observed to be o. k.

In the opinion of the undersigned, the dam, the dike and spillway are in the same good condition as previously reported, and are safe.

OK
FNU
224

1.

Dam/Town Ware . County Hampshire . Dam No. 2-8-309-13.

Name of Dam Quabbin "Spillway"

Topo Sheet No. 14D . Mass. Rect. Coordinates: N 470,200 , E 373,000

Inspected by: R. C. Salls, P.E., On Feb. 26, 1974. Date
Last Inspection 1970

See also Quabbin Winsor Dam No. 2-8-309-1A and Goodnough Dike No. 2-8-309-1C

2.

per: Assessors X, Pag. of Deeds , Prev. Insp. , Bar. Contact X.

[illegible]

2. _____				
Name	St. & No.	City/Town	State	Tel. No.

3. _____

Name	St. & No.	City/Town	State	Tel. No.
------	-----------	-----------	-------	----------

35

Mr. John W. Copithorne, Supt.

Quabbin Reservoir, M.D.C. - Wiscor Dam - Ware Rd., Belchertown, Mass. 013 - 321-5921

Name	St. & No.	City/Town	State	Tel. No.
------	-----------	-----------	-------	----------

④

No. of Pictures Taken 1. Sketches See description of Dem.
Plans, Where At M.D.C. office at Quabbin.

Copy of photo attached.

3.

1. Minor_____.

2. Moderate _____ 4. Disastrous _____

Comments: Assuming complete failure

---This rating may change as land use changes (future development).

6. OUTLETS: OUTLET CONTROLS AND DRAWDOWN See Inspection Report for Quabbin
"Winsor Dam" No. 2-8-309-1A

No. 1 Location and Type: _____.

Controls _____, Type: _____.

Automatic _____, Manual _____, Operative Yes _____, No _____.

Comments: _____.

No. 2 Location and Type: _____.

Controls _____, Type: _____.

Automatic _____, Manual _____, Operative Yes _____, No _____.

Comments: _____.

No. 3 Location and Type: _____.

Controls _____, Type: _____.

Automatic _____, Manual _____, Operative Yes _____, No _____.

Comments: _____.

Drawdown present Yes X, No _____, Operative Yes _____, No _____.

Comments: See Item 6 sub. 1 - Winsor Dam Inspection Report.

7. DAM UPSTREAM FACE: Slope 1 to 3.27, Depth Water at Dam crest of dam - El. 930 *Reservoir flow line at
Cut granite

Material: Turf _____, Brush & Trees _____, Rock fill _____, Masonry X, Wood _____.

Other _____.

Condition: 1. Good X, 3. Major Repairs _____.

2. Minor Repairs _____, 4. Urgent Repairs _____.

Comments: * At time of inspection water about 10' to 12' below crest of spillway.

8. DAM DOWNSTREAM FACE: Slope 1:1.

Material: Turf _____, Brush & Trees _____, Rock Fill _____, Cut granite
Masonry X, Wood _____.

Other _____.

Condition: 1. Good X, 3. Major Repairs _____.

2. Minor Repairs _____, 4. Urgent Repairs _____.

Comments: This spillway has not functioned for years

9. EMERGENCY SPILLWAY: Available Yes. Needed No.

Height Above Normal Water 6 Ft.

Width 200' Ft. Height 3 - 4 Ft. Material Earth channel
Masonry weir

Condition: 1. Good X. 3. Major Repairs _____.
2. Minor Repairs _____. 4. Urgent Repairs _____.

Comments: See sheet No. 6 of sketch with description of Winsor Dam

10. WATER LEVEL AT TIME OF INSPECTION: 12 Ft. Above _____. Below X _____.

Top Dam X P.L. Principal Spillway _____.

Other 12 ft. below crest of this spillway crest

Normal Freeboard 23 Ft.

11. SUMMARY OF DEFICIENCIES NOTED:

Growth (Trees and Brush) on Embankment None

Animal Burrows and Washouts None

Damage to Slopes or Top of Dam None

Cracked or Damaged Masonry None found

Evidence of Seepage None seen - no water in approach channel

Evidence of Piping None seen - no water in approach channel

Leaks None seen - no water in approach channel

Erosion None

Trash and/or Debris Impeding Flow None

Clogged or Blocked Spillway None

Other _____

(12)

OVERALL CONDITION:

1. Safe I
2. Minor repairs needed _____
3. Conditionally safe - major repairs needed _____
4. Unsafe _____
5. Reservoir impoundment no longer exists (explain)
Recommend removal from inspection list _____

(13)

REMARKS AND RECOMMENDATIONS: (Fully Explain)

This is the overflow spillway for the Quabbin Reservoir and is located northwesterly from the westerly end of the Winsor Dam about 1500 feet. It consists of a side channel spillway structure with granite stone masonry weir crest 370 feet long with its crest at elevation 530 or at the reservoir flow line elevation. There is a short 39 3/4 foot long weir section with the granite stone masonry walls crest at elevation 528.0 but with provisions for stop logs to elevation 530.0. A picture of this portion of the spillway weir is attached. This weir wall varies in height with a maximum of around 13 feet. The approach channel, the side channel trough and the downstream slope are all in rock excavation.

At the time of the inspection water in the reservoir was below to elevation of the bottom of the approach channel. Mr. Mellin, Assistant Superintendent, who accompanied us on our inspection, said that last year was the first time in many years that there was sufficient water in the reservoir so that a boat could enter the approach channel and that no water had flowed over spillway weir wall since 1961.

The Quabbin Spillway appeared to be in excellent condition with all the masonry of the crest and spillway wall without any evidence of deterioration, not even a mortar joint requiring pointing.

RCS/js/vk

DESCRIPTION OF DAM

DISTRICT 2

Submitted by R. C. Salls, P.E. Dam No. 2-8-309-1B
 Date February 26, 1974 County/Town Ware
 Name of Dam Quabbin "Spillway"

1. Location: Topo Sheet No. 14D Mass. Rect. Coordinates N 470,200 E 373,000
 Provide $8\frac{1}{2}$ " x 11" in clear copy of topo map with location of Dam clearly indicated.
Access from Ware Rd. "Rte. 9." about 2 1/2 miles easterly from junction with Rte. 21 - about 5000 ft. (1 mi.) north from Rte. 9 on Winsor Dam Rd. - Just after crossing Winsor Dam.
2. Year built 1976 - '8 Year/s of subsequent repairs Unknown
3. Purpose of Dam: Water Supply X Recreational _____
 Flood Control _____ Irrigation _____ Other _____
4. 186 sq. miles - plus limited diversion from Ware River - watershed 98 sq. miles
 Drainage Area: _____ sq. mi. _____ acres.
 Type: City, Bus. & Ind. _____ Dense Res. _____ Suburban _____ Rural, Farm 15%
 Wood & Scrub Land 85% Slope: Steep 15% Mod. 75% Slight 10%
5. 38.6 sq. mi.
 Normal Ponding Area: 24,704 Acres; Ave. Depth _____
 Impoundment: 412 billion gals.; Max. water depth 150 ft. acre ft.
 Silted in: Yes _____ No _____ Approx. Amount Storage Area _____
6. No. and type of dwellings located adjacent to pond or reservoir _____
 i.e. summer homes etc. Residences of operating personnel
7. 404 3/4
 Dimensions of Dam: Length See Note Max. Height 10 ft. ±
Freeboard 23' when reservoir at flow level
 Slopes: Upstream Face 1:1.27 batter - granite masonry
 Downstream Face 1:1 batter - granite masonry
Width across top Crest
370' masonry crest at 530 plus 3/4 3/4' stop log

Dam No. 2-8-309-1B

8.

Classification of Dam by Material:

Earth _____ Conc. Masonry _____ Granite _____
 Stone Masonry X
 Timber _____ Rockfill _____ Other _____

8A.

Dam Type: Gravity X Straight _____ Curved, Arched _____ Other _____
 Overflow X Non-overflow _____

9.

A. Description of present land usage downstream of dam:

90 % rural; 10 % ~~urban~~ developed - villages of Bondsville and Three Rivers

B. Is there a storage area or flood plain downstream of dam which could accommodate the impoundment in the event of a complete dam failure? Yes _____ No X

C. Character Downstream Valley: Narrow X Wide _____ Developed 10%
 Rural 90% Urban _____

10.

Risk to life and property in event of complete failure. * See note below.

No. of people Say 2 - 300 before Chiscopee River

No. of homes 30+ houses before villages of Bondsville and Three Rivers -
Say 2 - 300 housed before Chiscopee River

No. of businesses Numerous in villages

No. of industries Several light manufacturing plants

No. of utilities 4 Type Water supply - pole lines for telephone and electric plus electric transmission line

Railroads Boston & Maine and the Central Vermont R. R.

Other dams Bondsville Upper Dam No. 3-7-227-11 and Bondsville Lower Dam No. 3-7-227-12 on Swift River

Other State Fish Hatchery - numerous town highway and bridges - also Route 9 State Highway

11.

Attach sketch of dam to this form showing section and plan on 8 1/2" x 11" sheet.
 Sketch - 1 sheet.

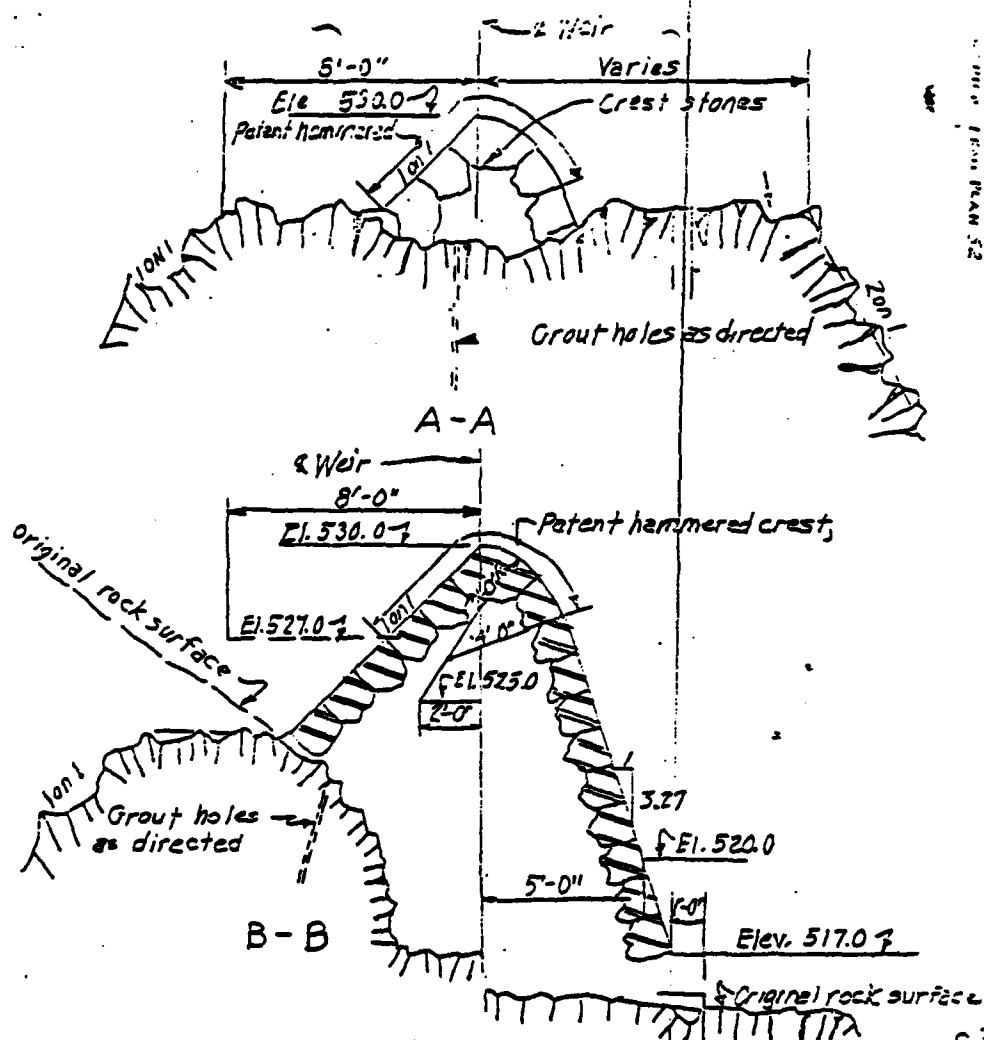
RCS/vk

Attachments

Locus Plan

Sketches

* Note: Risk to life and property shown along Swift River only. Damage is also likely on Chiscopee River.

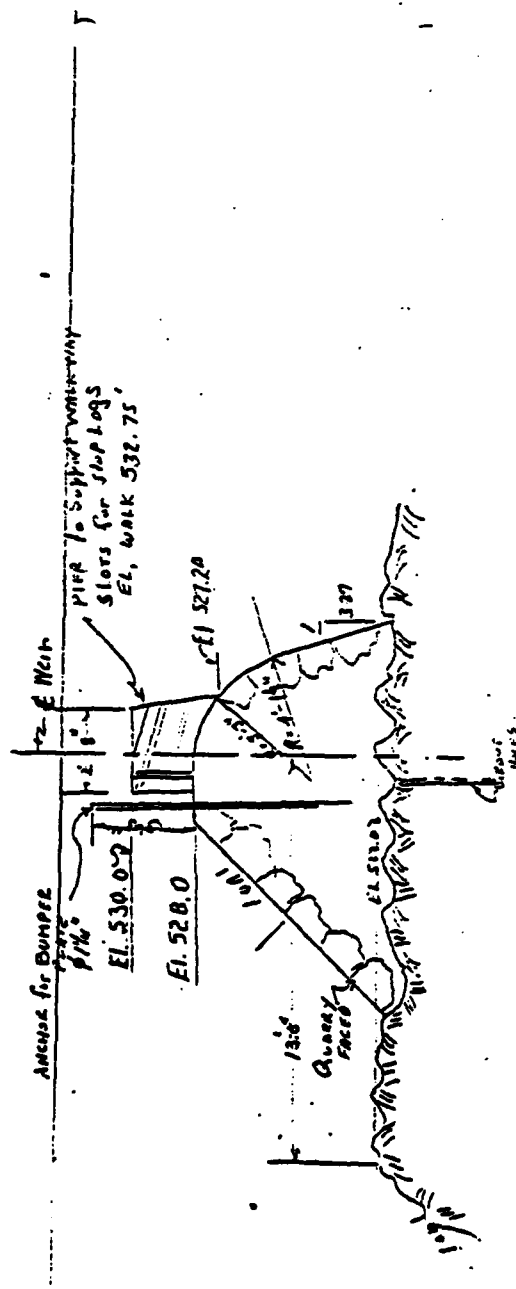


Sheet No. 11-2-00-3
 Date: 10-1-52

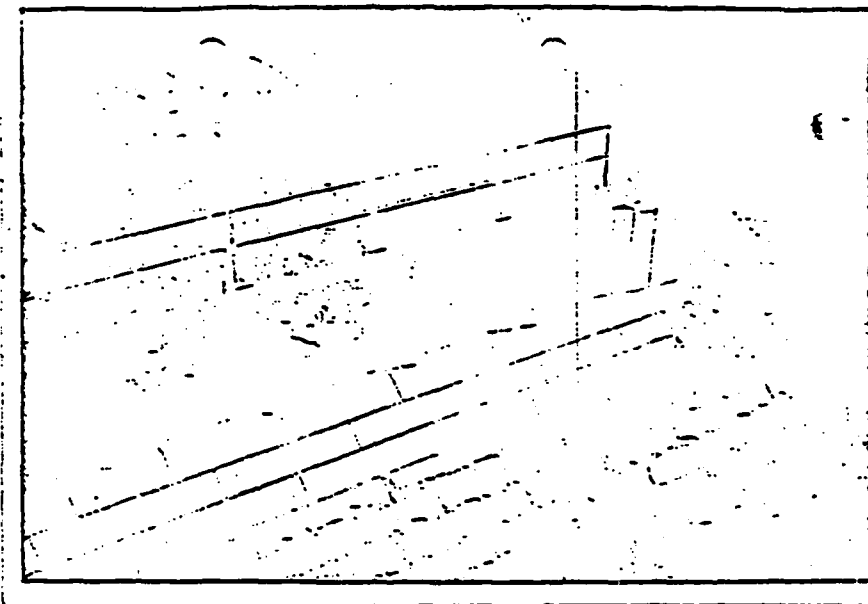
Drawn: M. J. ...

Scale: 1" = 10'-0"

SHEET NO 3 OF 3
 PROJECT : KWA CONTRACT # 52 PLAIN
 SURVEY No 13 D, F & C

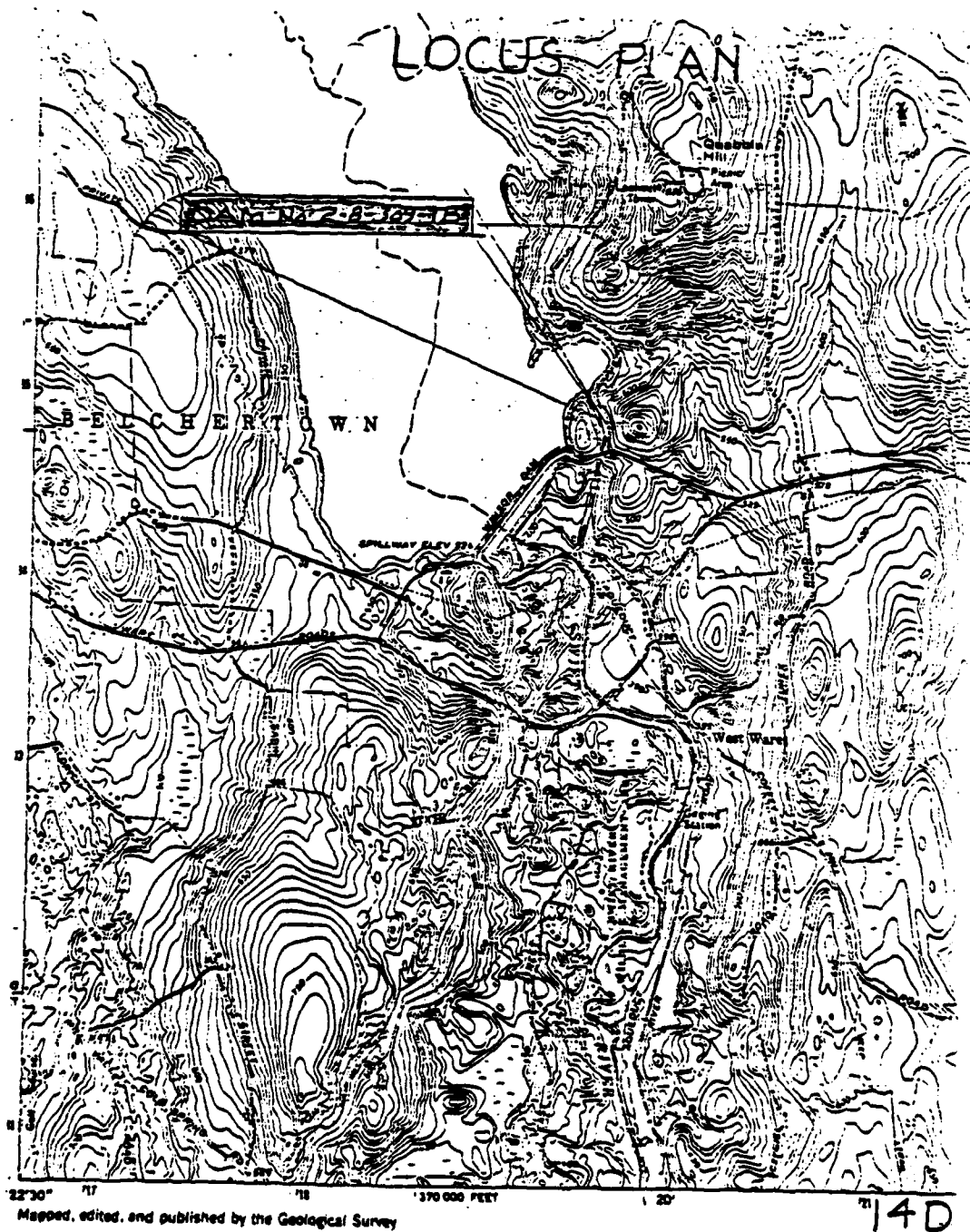


24.000



DAN No 2-8-309-1 B ATTACH to INSPECTION REPORT - 270 FEB 24, 1974

APPENDIX B-35





The Commonwealth of Massachusetts

EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL QUALITY ENGR.
DIVISION OF WATERWAYS

Metropolitan District Commission
Windsor Dam
Ware Road
Belchertown, Ma.

100 Nashua Street, Boston 02114

March 2, 1977

Re: Inspection Dam #2-6-309-1B
Quabbin Spillway Dam

Dear Sir:

On March 23, 1976, an Engineer from the Massachusetts Department of Public Works made a visual inspection of the above dam. Our records indicate the owner to be Metropolitan District Commission. If this information is incorrect will you please notify this office.

The inspection was made in accordance with the provisions of Chapter 253 of the Massachusetts General Laws as amended (Dams Safety Act). Chapter 706 of the Acts of 1975 transferred the jurisdiction of the so-called "Dams Safety Program" to the Commissioner of the Department of Environmental Quality Engineering.

The results of the inspection indicate that this dam is safe; however, the following conditions were noted that require attention:

SEE REMARKS AND RECOMMENDATIONS ON REVERSE SIDE.

We call these conditions to your attention before they become serious and more expensive to correct. With any correspondence please include the number of the Dam as indicated above.

Very truly yours,

John J. Hannon, P.E.
Chief Engineer

AMc:

cc: Francis J. Hoey
Russell Salls
Supt. Quabbin Reservoir
M.D.C. Windsor Dam
Ware Road
Belchertown, Ma.

APPENDIX B-37

REMARKS AND RECOMMENDATIONS

This is an overflow spillway for Quabbin Reservoir built of granite stone masonry and is 170' long with its crest elevation at 530.0. This spillway runs in a northerly-southerly direction and at the northerly end there is a short spillway 34.5 long running east-west. This spillway crest is at elevation 528.0 with provisions for stop logs to elevation 530.0. One stop log was in place at time of inspection with water overtopping this stop log 10" to 12" or just 6" below crest of main spillway. This is the first time since 1961 that the water level of reservoir has reached this elevation.

Mr. Donald Slonwhite of the N.D.CQ Winsor Dam Headquarters accompanied the inspection tour. He stated that the seepage from the spillway dropwall would be closely checked and the masonry joints would be investigated as soon as feasible.

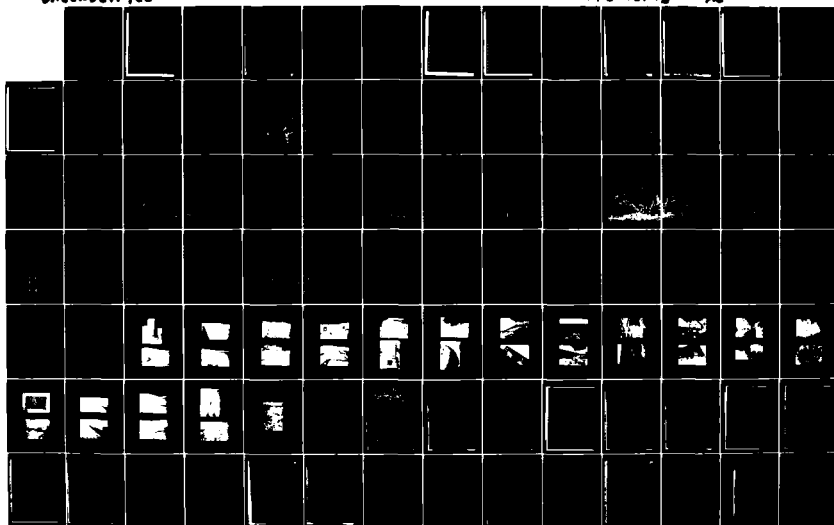
AD-A155 515 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
WINSOR DAM (MA 00588)...(U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV SEP 78

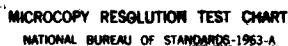
AD-A155 515 NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
WINSOR DAM (MA 00588)...(U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV SEP 78

2/3

UNCLASSIFIED

F/G 13/12 ML





INSPECTION REPORT - DAMS AND RESERVOIRS

1. LOCATION:

State/Town Ware County Hampshire Dam No. 2-B-300-1B
 Name of Dam Quabbin "Spillway"
 Mass. Sect.
 Topo Sheet No. 14 D Coordinates: N 870,200 E 373,000
 Inspected by: Harold T. Shumway On March 23, 1976 Date
 Last Inspection 2-26-74

2. OWNER/S: As of March 23, 1976

per: Assessors , Reg. of Deeds , Prev. Insp. X, Per. Contact X

1. Metropolitan District Commission, Winsor Dam, Ware Rd., Belchertown, Mass.
 Name St. & No. City/Town State Tel. No.

2.
 Name St. & No. City/Town State Tel. No.

3.
 Name St. & No. City/Town State Tel. No.

3. CARETAKER: (if any) e.g. superintendent, plant manager, appointed by
 absentee owner, appointed by multi owners.
Superintendent, Quabbin Reservoir,
M.D.C. - Winsor Dam, Ware Rd., Belchertown, Mass.

Name St. & No. City/Town State Tel. No.

4. DATA:

No. of Pictures Taken None Sketches See description of Dam.
 Plans, Where At M.D.C. Office at Quabbin Headquarters - Winsor Dam.

5. DEGREE OF HAZARD: (if dam should fail completely)*

1. Minor 3. Severe X

2. Moderate 4. Catastrophic

Comments:

*This rating may change as land use changes (future development).

⑥ OUTLETS: OUTLET CONTROLS AND DRAWDOWN

No. 1 Location and Type: Northerly end of main spillway - quarry stone faced crest
overflow spillway - 34'-8"W. x 2'H. to level of main spillway
elevation.

Controls Yes, TYPE: Step logs

Automatic , Manual X, Operative Yes X, No .

Comments: One 8" high step log in place at time of inspection

No. 2 Location and Type: 700' to 800' northeasterly of Winsor Dam - quarried stone
faced main spillway - 370' W. x 23' - H.

Controls None, Type:

Automatic , Manual , Operative Yes , No .

Comments: Crest of main spillway at elevation 530' - normal flow line of reservoir.

No. 3 Location and Type:

Controls , Type:

Automatic , Manual , Operative Yes , No .

Comments:

Drawdown present Yes X, No , Operative Yes , No .

Comments: See Item 6 - sub.1 - Winsor Dam Report No. 2-8-309-1A

⑦ DAM UPSTREAM FACE: Slope 1:1.27, Depth Water at Dam 6' to 12'

Material: Turf , Brush & Trees , Rock fill , Masonry X, Wood

Other

Condition: 1. Good X, 3. Major Repairs

2. Minor Repairs , 4. Urgent Repairs

Comments:

⑧ DAM DOWNSTREAM FACE: Slope 1:1

Material: Turf , Brush & Trees , Rock Fill , Masonry X, Wood

Other

Condition: 1. Good , 3. Major Repairs

2. Minor Repairs X, 4. Urgent Repairs

seepage through joints between granite blocks - water level within

9. EMERGENCY SPILLWAY: Available Yes. Needed .
 Height Above Normal Water 6 Ft.
 Width 200 Ft. Height 3 to 4 Ft. Material Earth channel
Masonry weir
 Condition: 1. Good X. 3. Major Repairs .
 2. Minor Repairs . 4. Urgent Repairs .
 Comments: This ditch and weir appears to be well maintained and stable.

10. WATER LEVEL AT TIME OF INSPECTION: 1/2 Ft. Above . Below X .
 Top Dam P.L. Principal Spillway X .
 Other Water level at elev. 529.5
 Normal Freeboard 2 1/2 Ft.

11. SUMMARY OF DEFICIENCIES NOTED:
 Growth (Trees and Brush) on Embankment None found
 Animal Burrows and Washouts None found
 Damage to Slopes or Top of Dam None found
 Cracked or Damaged Masonry None found
 Evidence of Seepage Minor seepage noted on main spillway dropwall
 Evidence of Piping None noted
 Leaks None noted
 Erosion None noted
 Trash and/or Debris Impeding Flow None found
 Clogged or Blocked Spillway None found
 Other

OVERALL CONDITION:

1. Safe _____
2. Minor repairs needed X _____
3. Conditionally safe - major repairs needed _____
4. Unsafe _____
5. Reservoir impoundment no longer exists (explain)
Recommend removal from inspection list _____

REMARKS AND RECOMMENDATIONS: (Fully Explain)

This is an overflow spillway for Quabbin Reservoir built of granite stone masonry and is 370' long with its crest elevation at 530.0. This spillway runs in a northerly-southerly direction and at the northerly end there is a short spillway 34.5 long running east-west. This spillway crest is at elevation 528.0 with provisions for stop logs to elevation 530.0. One stop log was in place at time of inspection with water overtopping this stop log 10" to 12" or just 6" below crest of main spillway. This is the first time since 1961 that the water level of reservoir has reached this elevation.

Mr. Donald Sloughwhite of the N.D.C. Winsor Dam Headquarters accompanied the inspection tour. He stated that the seepage from the spillway dropwall would be closely checked and the masonry joints would be investigated as soon as feasible.

This spillway structure appears basically sound and safe at time of inspection.

RIS/vk

GOODNOUGH DIKE

G. Quabbin Dike, Winsor Dam and Spillway

The grass cover on the embankment forming the dike was noted to be o.k. The toe area of the dry side was in good condition and dry. The road on top of the embankment was in good condition and there was no evidence of settlement, sunken areas or cracks. The rock fill slope on the reservoir side of the dike is in good condition. Water in storage was observed to be quite low but appeared to be higher in elevation than at the time of the previous inspection.

The main dam, Winsor Dam, was noted to be in good condition. The turf cover on the downstream slope was good. Some areas apparently are being re-leamed, treated and seeded. The toe area of this main dam was dry.

The rock filled portion of the main dam on the reservoir side was in good condition. The road across the dam was o.k.

The spillway structure was again observed to be completely dry. The spillway has not been wet for many years. However, the level of water observed this year is at the entrance to the spillway forebay and thus is the highest noted in many years. The stone masonry of the spillway and the crest were observed to be o.k.

In the opinion of the undersigned, the dam, the dike and spillway are in the same good condition as previously reported, and are safe.

INSPECTION REPORT - DAMS AND RESERVOIRS

1. LOCATION:

Town/Water Ware County Hampshire Dam No. 2-8-309-1C

Name of Dam Quabbin "Goodnough Dike"

Mass. Rect.

Topo Sheet No. 14D Coordinates: N 473,900 E 784,000

Inspected by: R. C. Salls, P.E. On Feb. 26, 1974. Date Last Inspection 1970

See also Quabbin "Winsor" Dam No. 2-8-309-1A and Quabbin "Spillway" No. 2-8-309-1B

2. OWNER/S: As of November 1972

per: Assessors X, Reg. of Deeds, Prev. Insp., Per. Contact X

1. Metropolitan District Commission, Winsor Dam, Ware Rd., Belchertown, Mass.
Name St. & No. City/Town State Tel. No.

2. Name St. & No. City/Town State Tel. No.

3. Name St. & No. City/Town State Tel. No.

3. CARETAKER: (if any) e.g. superintendent, plant manager, appointed by absentee owner, appointed by multi owners.
Mr. John W. Copithorne, Supt.

Quabbin Reservoir - M.D.C. Winsor Dam - Ware Rd., Belchertown, Mass. 413-273-6021
Name St. & No. City/Town State Tel. No.

4. DATA:

No. of Pictures Taken None Sketches See description of Dam.
Plans, Where At M.D.C. office at Quabbin

5. DEGREE OF HAZARD: (if dam should fail completely)*

1. Minor 3. Severe

2. Moderate 4. Disastrous X

Comments: Assuming complete failure

*This rating may change as land use changes (future development).

⑥ OUTLETS: OUTLET CONTROLS AND DRAWDOWN See Inspection Report for Quabbin "Winsor Dam"
No. 2-8-309-1A.

No. 1 Location and Type: _____

Controls _____, Type: _____

Automatic _____, Manual _____, Operative Yes _____, No _____.

Comments: _____

No. 2 Location and Type: _____

Controls _____, Type: _____

Automatic _____, Manual _____, Operative Yes _____, No _____.

Comments: _____

No. 3 Location and Type: _____

Controls _____, Type: _____

Automatic _____, Manual _____, Operative Yes _____, No _____.

Comments: _____

Drawdown present Yes X, No _____, Operative Yes _____, No _____.

Comments: See Item 5 - Sub. 1 - Winsor Dam Inspection Report

⑦ DAM UPSTREAM FACE: Slope Varies 1 1/2:1 to 3:1, Depth Water at Dam 175'.
Material: Turf _____, Brush & Trees _____, Rock fill X, Masonry _____, Wood _____.
Other 2 berm on slope - rock fill thickened 10' thick at reservoir flow line elevation.
Condition: 1. Good X, 2. Minor Repairs _____, 3. Major Repairs _____, 4. Urgent Repairs _____.
Comments: For details see sketch - sheet 3.

⑧ DAM DOWNSTREAM FACE: Slope 2:1 and 2 1/2:1.
Material: Turf X, Brush & Trees _____, Rock Fill _____, Masonry _____, Wood _____.
Other 2 berm on slope - slope drainage in place catch basin and underdrain.
Condition: 1. Good X, 2. Minor Repairs _____, 3. Major Repairs _____, 4. Urgent Repairs _____.
Comments: Note: One fresh woodchuck hole found on lower southwesterly portion of slope. Swamp and/or beaver impoundment just south of east access road - about 300 ft. from toe.

9. EMERGENCY SPILLWAY: Available Yes. Needed No.

Height Above Normal Water 6 Ft. auxiliary spillway
 Width 200 Ft. Height 3 to 4 Ft. Material Earth channel
Masonry weir
 Condition: 1. Good X. 3. Major Repairs _____
 2. Minor Repairs _____. 4. Urgent Repairs _____

Comments: See sheet 6 of sketches for Winsor Dam No. 2-8-309-1A.
See also Quabbin Spillway No. 2-8-309-1B

10. WATER LEVEL AT TIME OF INSPECTION: 35 Ft. Above _____. Below X _____.

Top Dam X F.L. Principal Spillway _____.

Other _____.

Normal Freeboard 23 Ft.

11. SUMMARY OF DEFICIENCIES NOTED:

Growth (Trees and Brush) on Embankment None
 Animal Burrows and Washouts One fresh woodchuck hole on lower portion of southwestern downstream slope
 Damage to Slopes or Top of Dam None. Slope moved and turf cared for _____
 Cracked or Damaged Masonry None
 Evidence of Seepage Minor seepage - handled by drainage system
 Evidence of Piping None seen
 Leaks None seen
 Erosion None seen
 Trash and/or Debris Impeding Flow None
 Clogged or Blocked Spillway None
 Other _____

(12)

OVERALL CONDITION:

1. Safe I.
2. Minor repairs needed _____.
3. Conditionally safe - major repairs needed _____.
4. Unsafe _____.
5. Reservoir impoundment no longer exists (explain)
Recommend removal from inspection list _____.

(13)

REMARKS AND RECOMMENDATIONS: (Fully Explain)

This dike closes a low area westerly about $2\frac{1}{2}$ miles of the Winsor Dam and closes off the head of the Beaver Brook valley. It is a full hydraulic fill embankment 135 feet high and 2600 feet long with a concrete caisson core wall from the approximate level of the original ground to sound bedrock along the centerline of the dam. The embankment upstream slope has a riprap shell in good condition. The downstream slope is covered with a mowed turf in good condition with surface water and seepage controlled by a drainage system. A single woodchuck hole of recent origin was found on the lower southwesterly portion of the slope but Mr. Mallin, Assistant Superintendent, said that this would be taken care of during spring maintenance.

There was originally an observation wall near the center of the dam which was abandoned around 1941 and filled with loam so no recent observations are available.

Precise levels were taken along the top of the dam at frequent intervals until 1957 and a set was taken in 1971. These showed a total settlement of about $1\frac{1}{2}$ feet in 1971 with about $\frac{1}{3}$ of this settlement occurring during the period from 1957 to 1971. This dam was originally designed with a 2 foot camber to allow for settlement.

RCS/js/vk

DESCRIPTION OF DAM

DISTRICT 2

Submitted by R. C. Salls, P.E. Dam No. 2-8-309-1C
 Date Feb. 26, 1974 ~~City/Town~~ Ware
 Name of Dam Quabbin "Goodnough Dike"

1. Location: Topo Sheet No. 14D Mass. Rect. Coordinates N 473,000 E 784,000
 Provide 8 1/2" x 11" in clear copy of topo map with location of Dam clearly indicated.
Access from Rte. 9, about 2 1/2 mi. westerly from Ware Center at Quabbin Park Cemetery northerly via Enfield Rd. about 8/10 mi., then right on Dike Rd. for 5/10 mile. Road goes over dike. Dike crosses off Beaver Brook valley.
2. Year built 1926 - 28 Year/s of subsequent repairs 1970
3. Purpose of Dam: Water Supply X Recreational _____
 Flood Control _____ Irrigation _____ Other _____
4. 186 sq. mi. plus limited diversion from Ware River watershed of 98 sq. mi.
 Drainage Area: _____ sq. mi. _____ acres.
 Type: City, Bus. & Ind. _____ Dense Res. _____ Suburban _____ Rural, Farm 15%
 Wood & Scrub Land 85% Slope: Steep 15% Med. 75% Slight 10%
5. 38.6 sq. mi.
 Normal Ponding Area: 247,704 Acres; Ave. Depth _____ Max. depth 150 ft.
 Impoundment: 412 billion gals.; _____ acre ft.
 Silted in: Yes _____ No _____ approx. Amount Storage Area Unknown
6. No. and type of dwellings located adjacent to pond or reservoir _____
 i.e. summer homes etc. Residences of operating personnel
7. Dimensions of Dam: Length 2140 ft. Max. Height 175 ft.
23' to top of embankment when full
 Freeboard 52' at crest of spillway
 Slopes: Upstream Face Varies 1 1/4 to 1 to 3/4 - 1 to 1
Downstream Face Varies 2 to 2 1/2 - 1 to 1
 Width across top 34 3/4 - paved roadway

Dam No. 2-8-309-1C

8. Classification of Dam by Material:

Earth X Conc. Masonry _____ Stone Masonry _____
Hydraulic fill embankment _____
Timber _____ Rockfill _____ Other Concrete caisson core wall

8a.

Dam Type: Gravity X Straight X Curved, Arched _____ Other _____
Overflow _____ Non-overflow X

9.

A. Description of present land usage downstream of dam:

100 % rural; _____ % urban developed

B. Is there a storage area or flood plain downstream of dam which could accommodate the impoundment in the event of a complete dam failure? Yes _____ No X

C. Character Downstream Valley: Narrow X Wide _____ Developed _____
Rural _____ Urban _____

10.

Risk to life and property in event of complete failure. * See note below.

No. of people 5

No. of homes 5 full time homes - 17² cottages

No. of businesses None

No. of industries None Type _____

No. of utilities 3 Type City of Boston water supply
Electric and telephone lines
Electrical transmission line

Railroads None

Other dams Pepper Mill Pond Dam No. 2-8-309-2; Beaver Lake Dam No. 2-8-309-3

Other Route 9 - plus 2 town roads

11.

Attach Sketch of dam to this form showing section and plan on 8 $\frac{1}{2}$ " x 11" sheet.

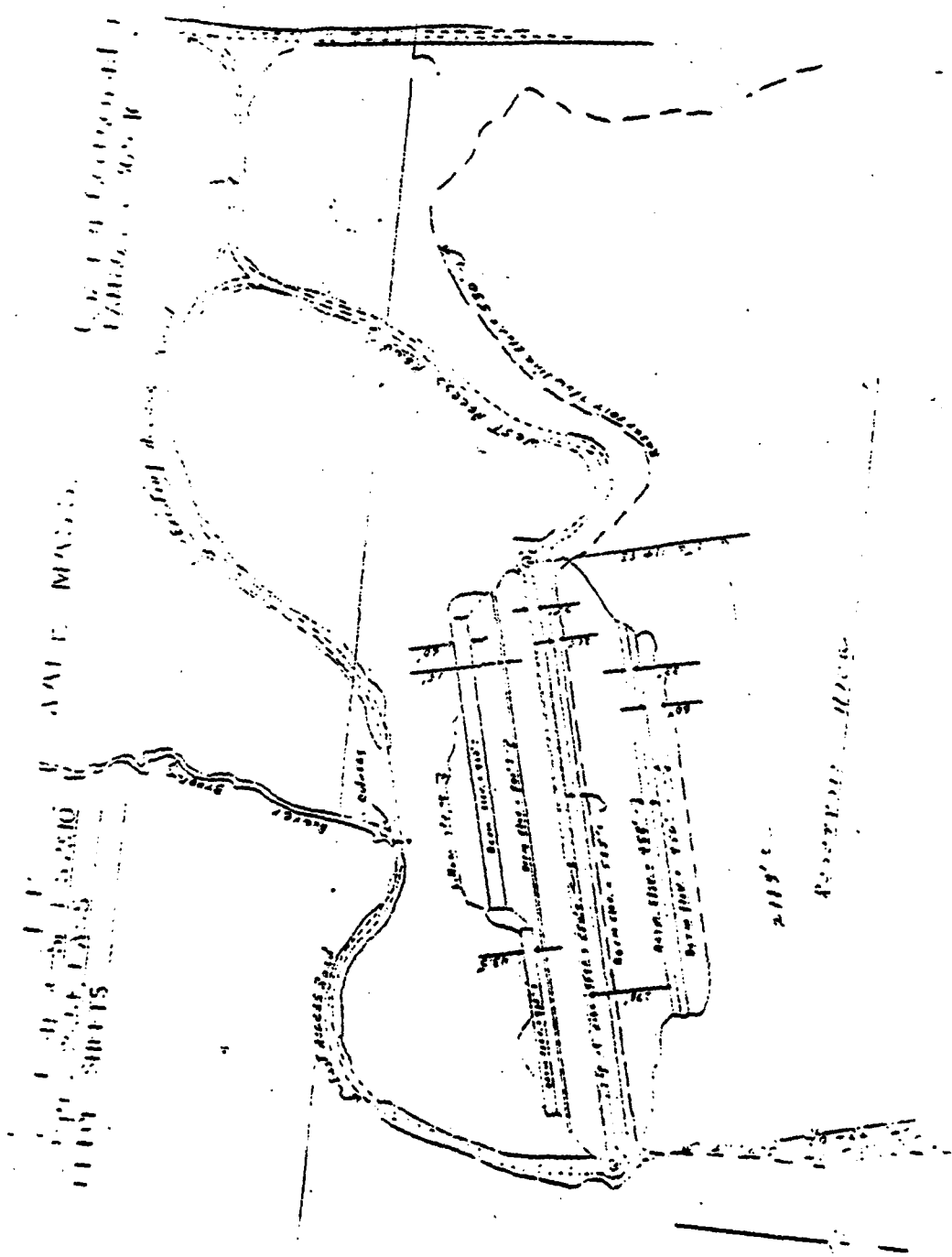
RCS/vk

Attachments

Locus Plan

Sketches

* Risk to life and property only on Beaver Brook, possibility of extensive damage along Ware River in Palmer.

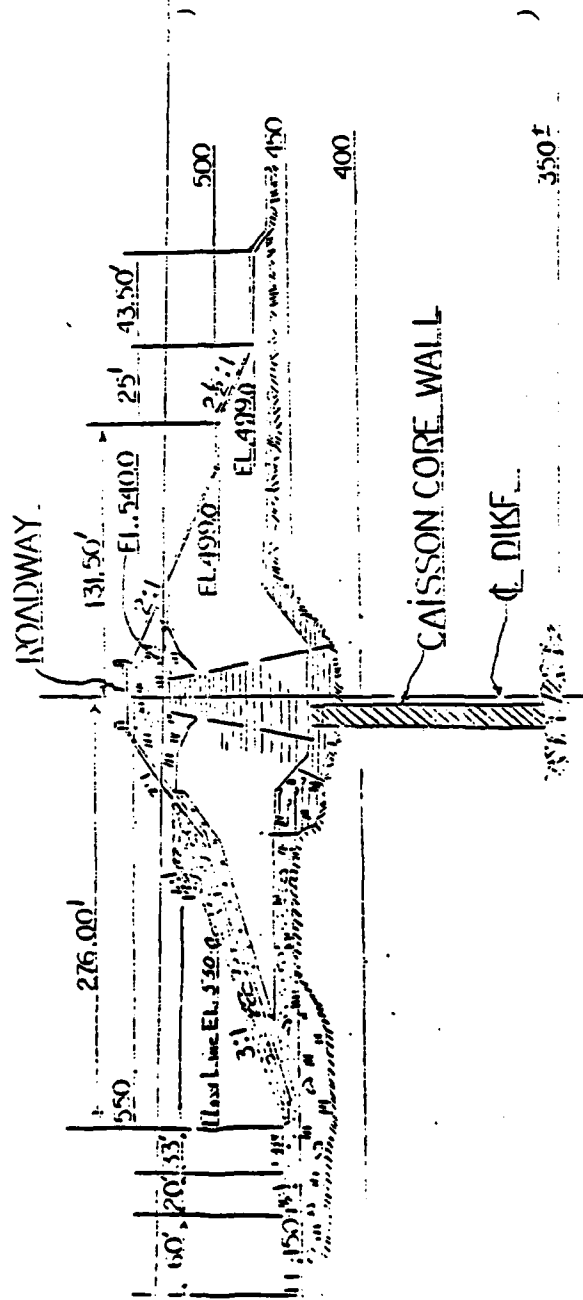


EXERCISES TO FOLLOW

LINE FLANKING—PROFILE ON CENTER LINE OF DIKE

CLICHÉ
 QUABBIN CONDUIT DIKE
 WARE, MASS.
 SHEET 3 OF 3 SHEETS

DAM NO. 26-90-R



X-SECTION STA. 25+40

P.B.G., JR.
 2/26/74

LOCUS PLAT



14D



File 1129 P41

CONTRACT 52 SHEET 2
36 SHEETS IN SET

Commonwealth
of
Massachusetts

LEGEND

- Rock outcrops
- Boring location and number
- Limits of sprout land or wooded area
- Swamp
- Paths
- Suggested borrow areas
- T.P. 151 Test pit location and number

Shovel cuts B, D and E shown full have been completed under a previous contract.
Cuts J, K, L, M, N, P and Q shown dotted are being excavated by the Commission, some by power shovel. These investigations will be completed and records available by June 17, 1936.

Note: This area is reserved for construction of buildings under another contract, and the Contractor's operations near this area shall not interfere with that work.

Notes:-
Elevations - Boston City Base.
Coordinates and bearings - Quabbin (formerly Swift River) Reservoir System.

The plan, profile and cross sections of the Main Dam Embankment see Sheets 1, 4 and 3 respectively.
Records of investigations of borrow pit materials may be seen at the office of the Engineer. Preliminary investigations indicate suitable materials for use under Items 8 and 15 may be found in the "Permitted Borrow Areas" but the Contractor will be allowed to borrow from any permitted areas only to the extent that the materials are satisfactory for their intended use. In addition, materials for use under Item 15 may be obtained from other permitted areas below Elev. 530 more than 1000 feet upstream from the upstream toe of the dam.

The existence or sufficiency of suitable materials for Item 8 or any other item in any one borrow area shown is not guaranteed.

COMMONWEALTH OF MASSACHUSETTS
METR. DIST. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
MAIN DAM EMBANKMENT
GENERAL PLAN

400 200 0 200 400 feet

JUNE 1, 1936

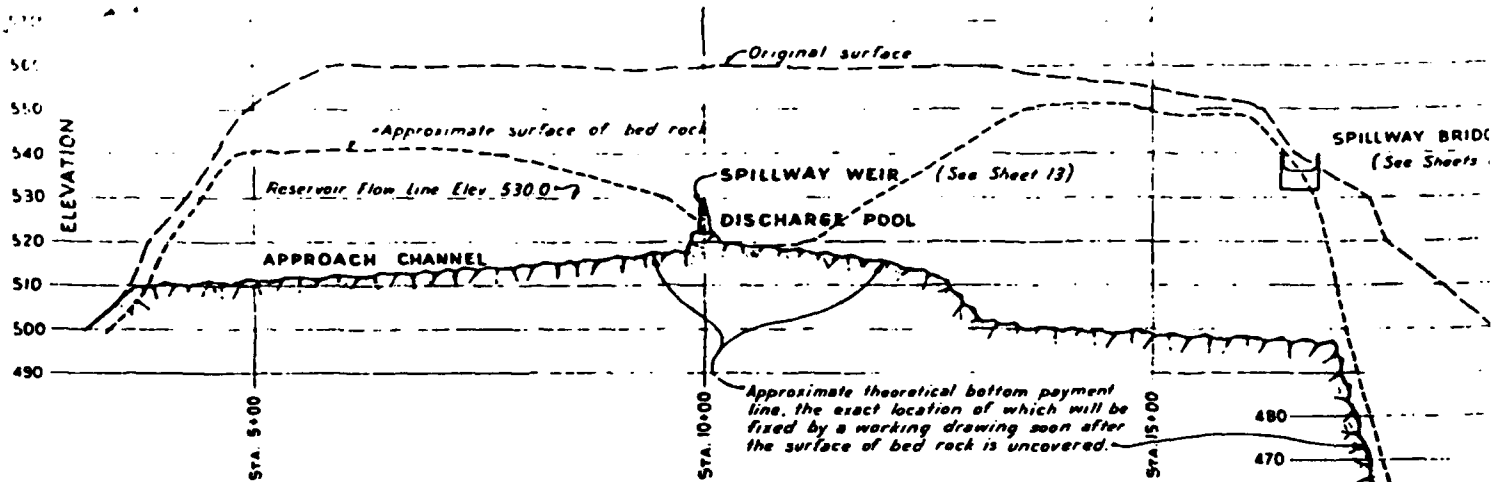
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FILE CONT. 52-2,325

Acc. 24,102

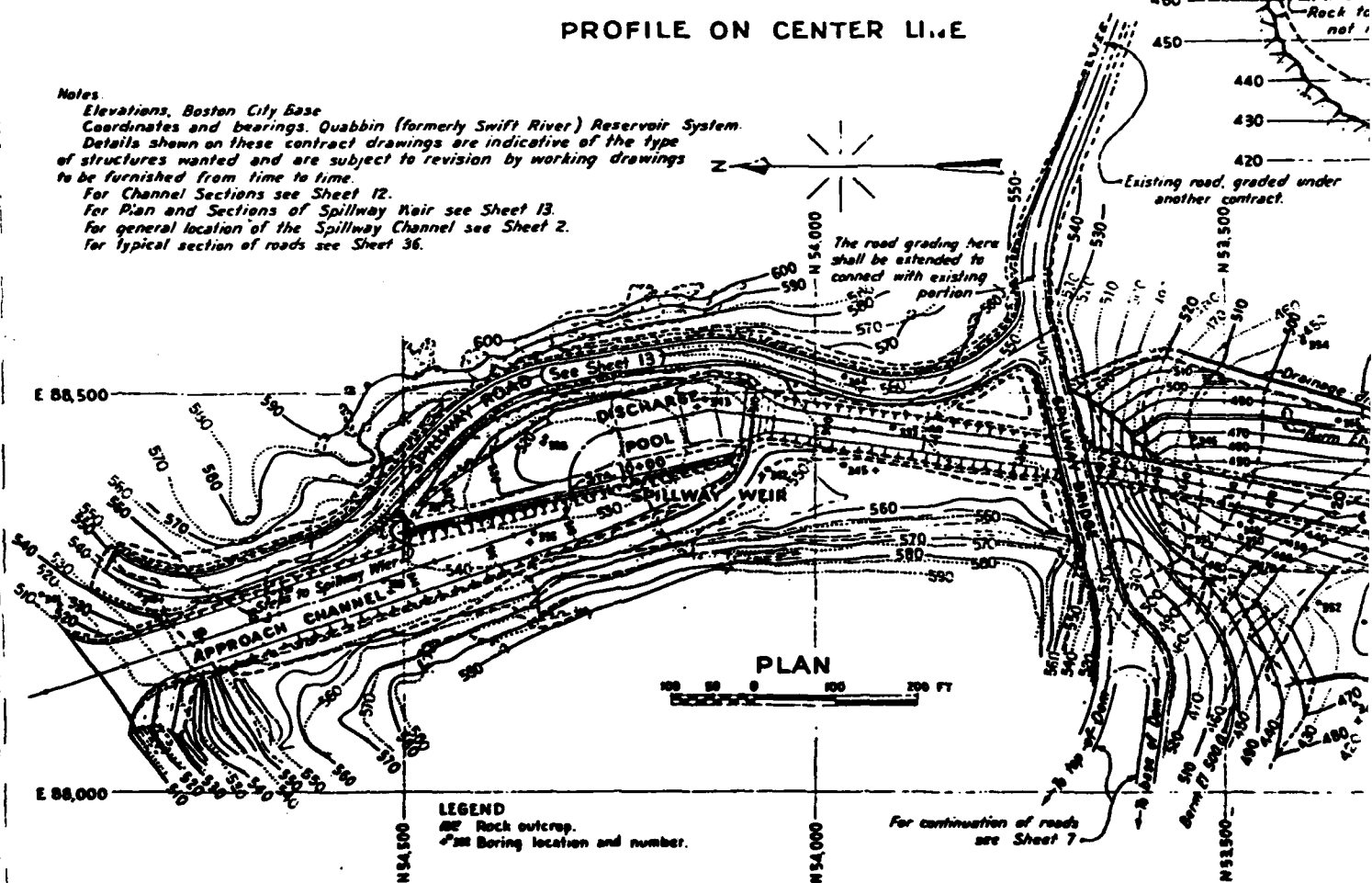
APPENDIX B-54

(2)



PROFILE ON CENTER LINE

Notes.
 Elevations, Boston City Base
 Coordinates and bearings, Quabbin (formerly Swift River) Reservoir System.
 Details shown on these contract drawings are indicative of the type of structures wanted and are subject to revision by working drawings to be furnished from time to time.
 For Channel Sections see Sheet 12.
 For Plan and Sections of Spillway Weir see Sheet 13.
 For general location of the Spillway Channel see Sheet 2.
 For typical section of roads see Sheet 36.



File 4160 R44

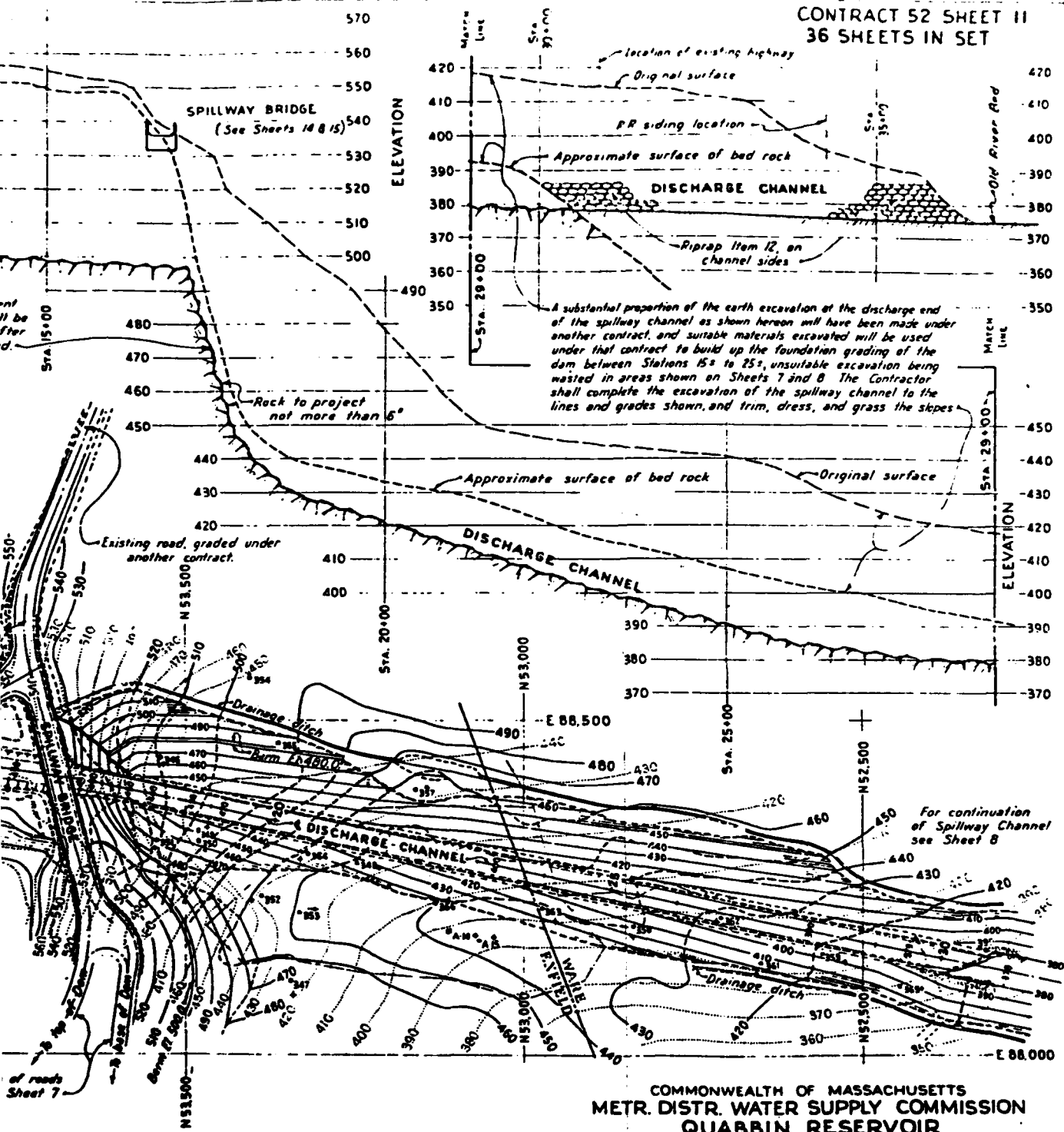
Designed AL
 Drawn LAH
 Traced LAH
 Checked LAH

Frank H. Thompson
 Asst Chief Engineer

David H. Ellsworth
 Chief Engineer

Charles V. Mann
 Consulting

CONTRACT 52 SHEET 11
36 SHEETS IN SET



COMMONWEALTH OF MASSACHUSETTS
METR. DIST. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
MAIN DAM EMBANKMENT
SPILLWAY CHANNEL - SHEET 1

SCALES AS NOTED

JUNE 1, 1936

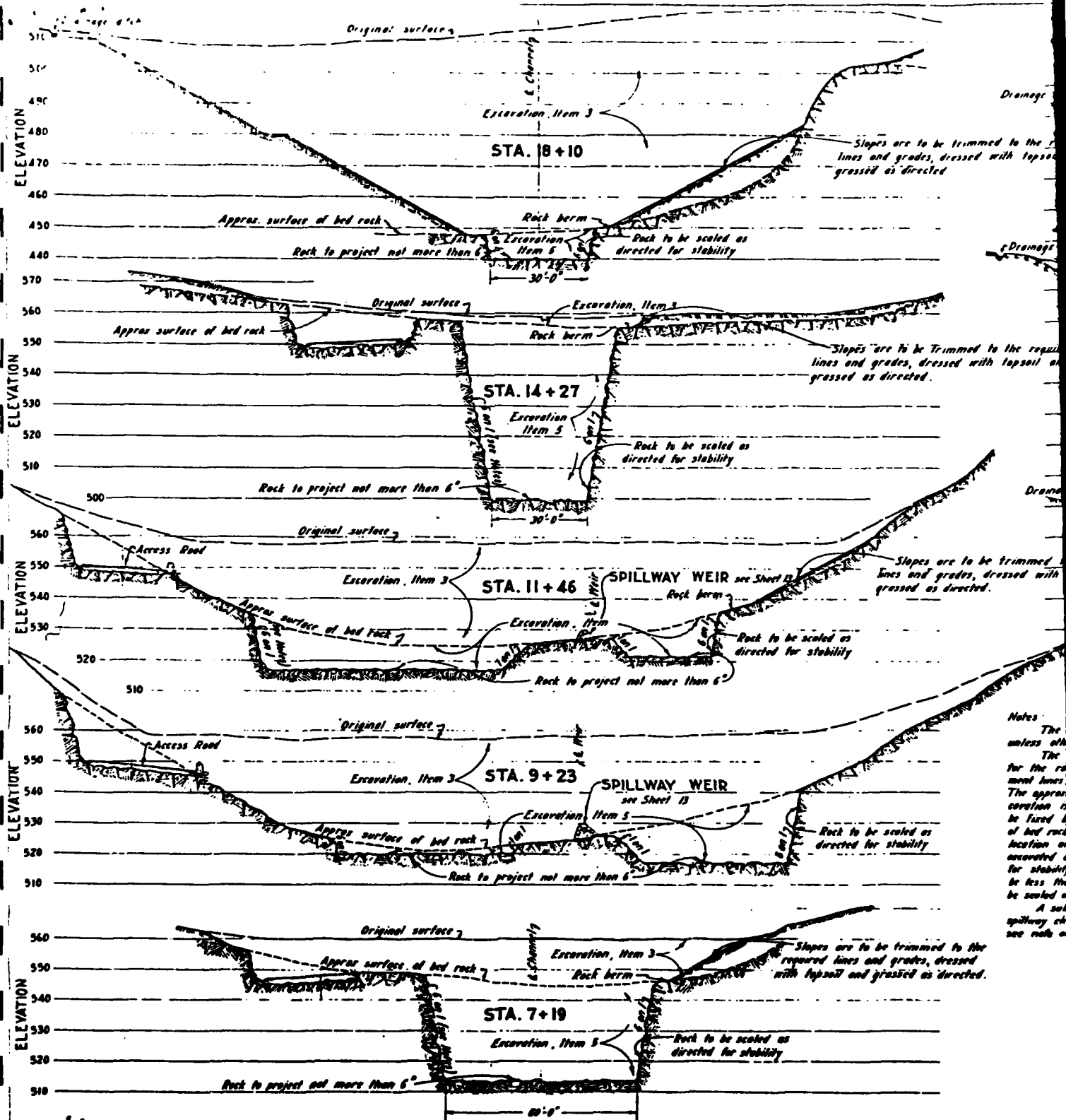
Charles T. Mann
Consulting Engineer

FILE: CONT. 52-232-5

Acc 24, 11

APPENDIX B-55

②



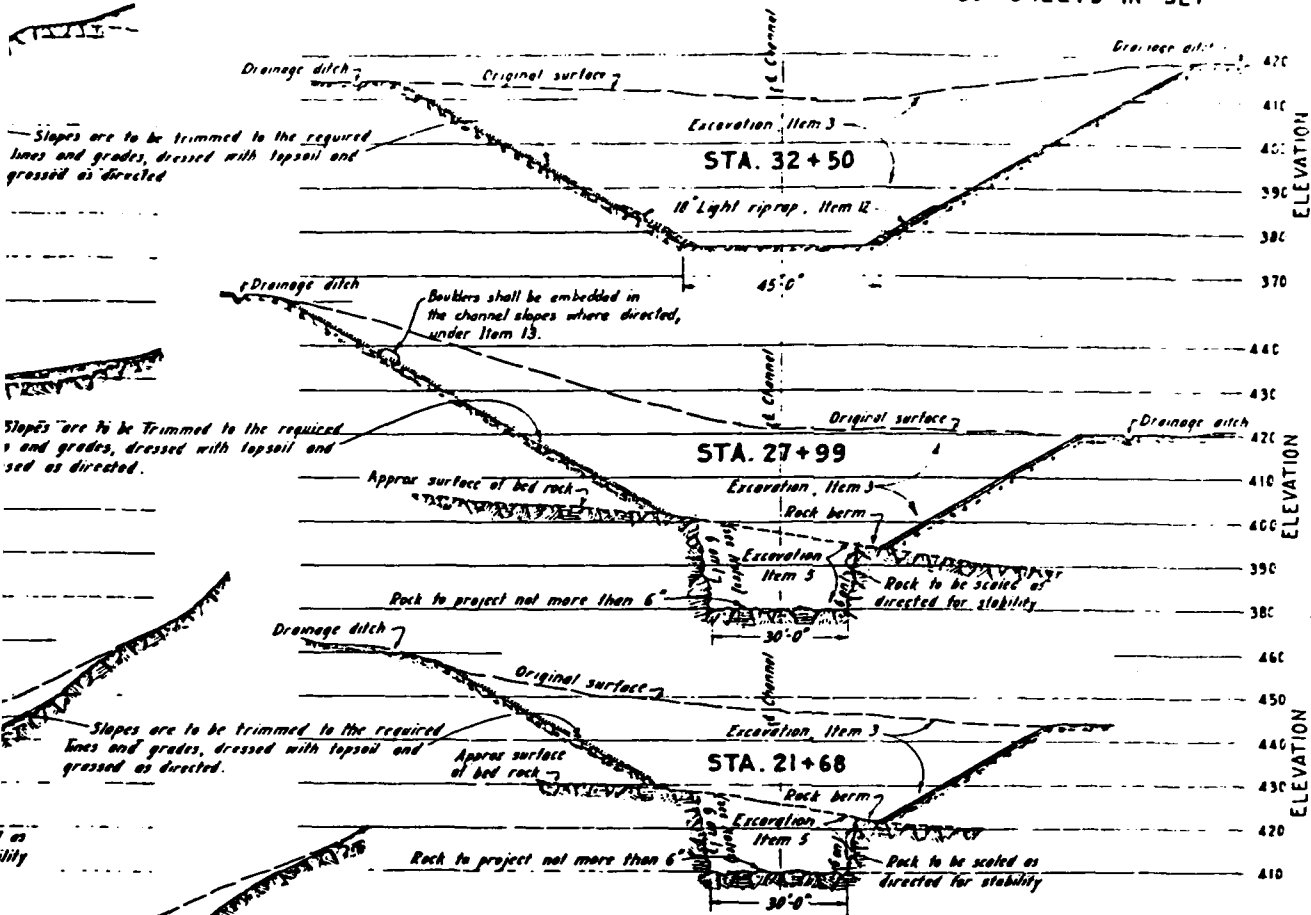
Notes:
The
unless otherwise
The
for the required
The
excavation is
be fixed by
of bed rock
location of
uncovered &
for stability
be less than
be sealed at
A sub
spillway ch
see note on

Designed: A.H.
Drawn: J.E.V.
Traced: B.H.
Checked: J.G.D.

John R. Hamilton
Ass't. Chief Engineer

David S. Hamilton
Chief Engineer

CONTRACT 52 SHEET 12
36 SHEETS IN SET



Notes:

The rock berms shown are to be about 5 feet wide unless otherwise directed.

The theoretical side slope and bottom lines shown for the rock excavation of the spillway channel are payment lines, regardless of the quantities actually excavated. The approximate elevation of the bottom of this rock excavation is shown on Sheet 11. The exact location will be fixed by a working drawing soon after the surface of bed rock is uncovered. The bottom widths for this location are fixed as shown. The 6' on 1' slopes are to be excavated as steep as the character of the rock allows for stability. The width of the channel shall not be less than the bottom width shown, and the sides shall be sealed of loose fragments.

A substantial proportion of the earth excavation of the spillway channel will have been made under another contract, see note on profile of Sheet 11.

Notes:

Elevations, Boston City Base
For locations of the channel sections and for plan and profile of Spillway Channel see Sheet 11.
For plan and details of Spillway Pier see Sheet 13
Details shown on these contract drawings are indicative of the type of structures wanted and are subject to revision by working drawings to be furnished from time to time.

COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
MAIN DAM EMBANKMENT
SPILLWAY CHANNEL - SHEET 2



JUNE 1, 1936.

Chief Engineer

Charles T. Mann
Consulting Engineer

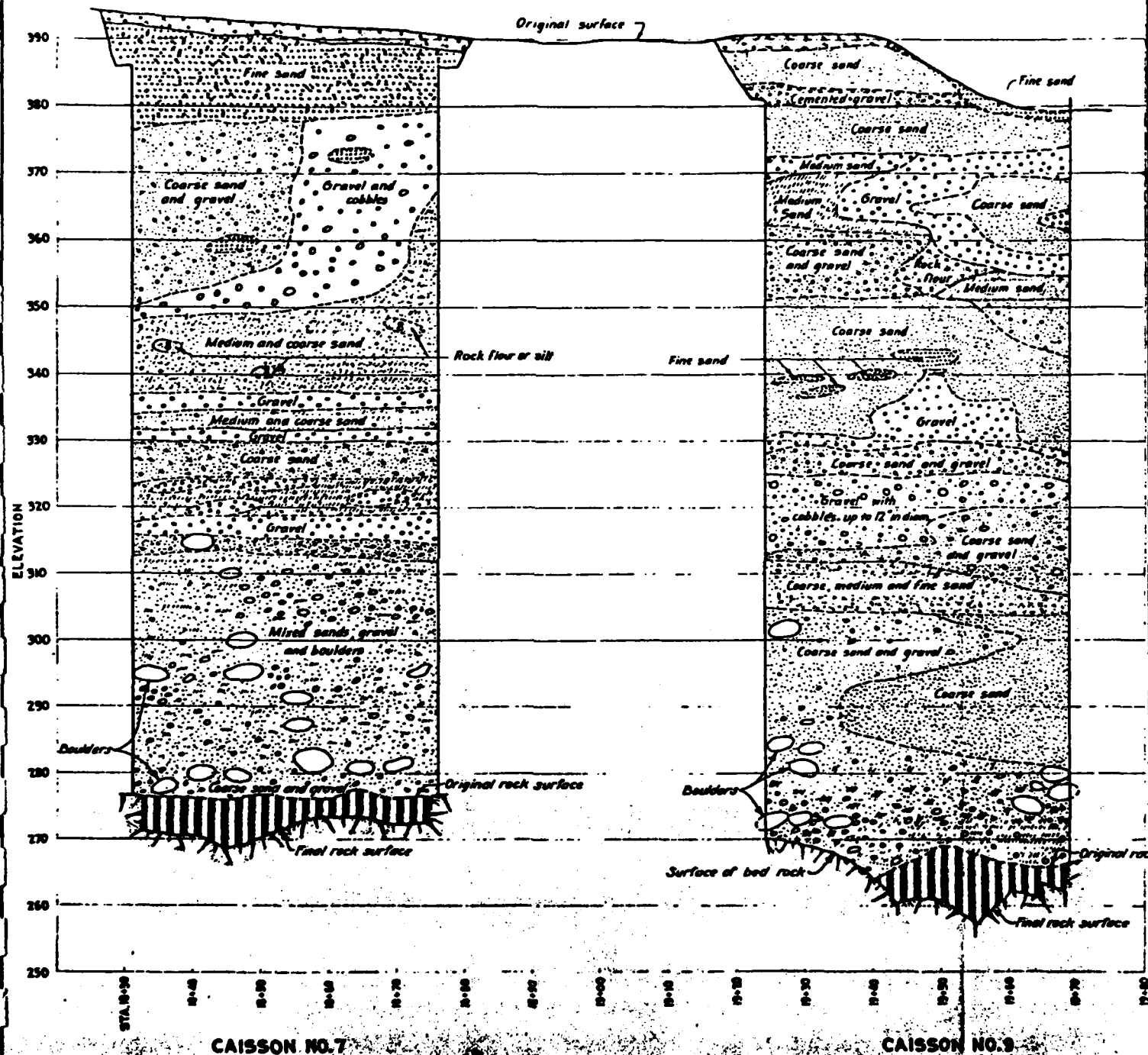
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APPENDIX B-56

2

File 4160-B37

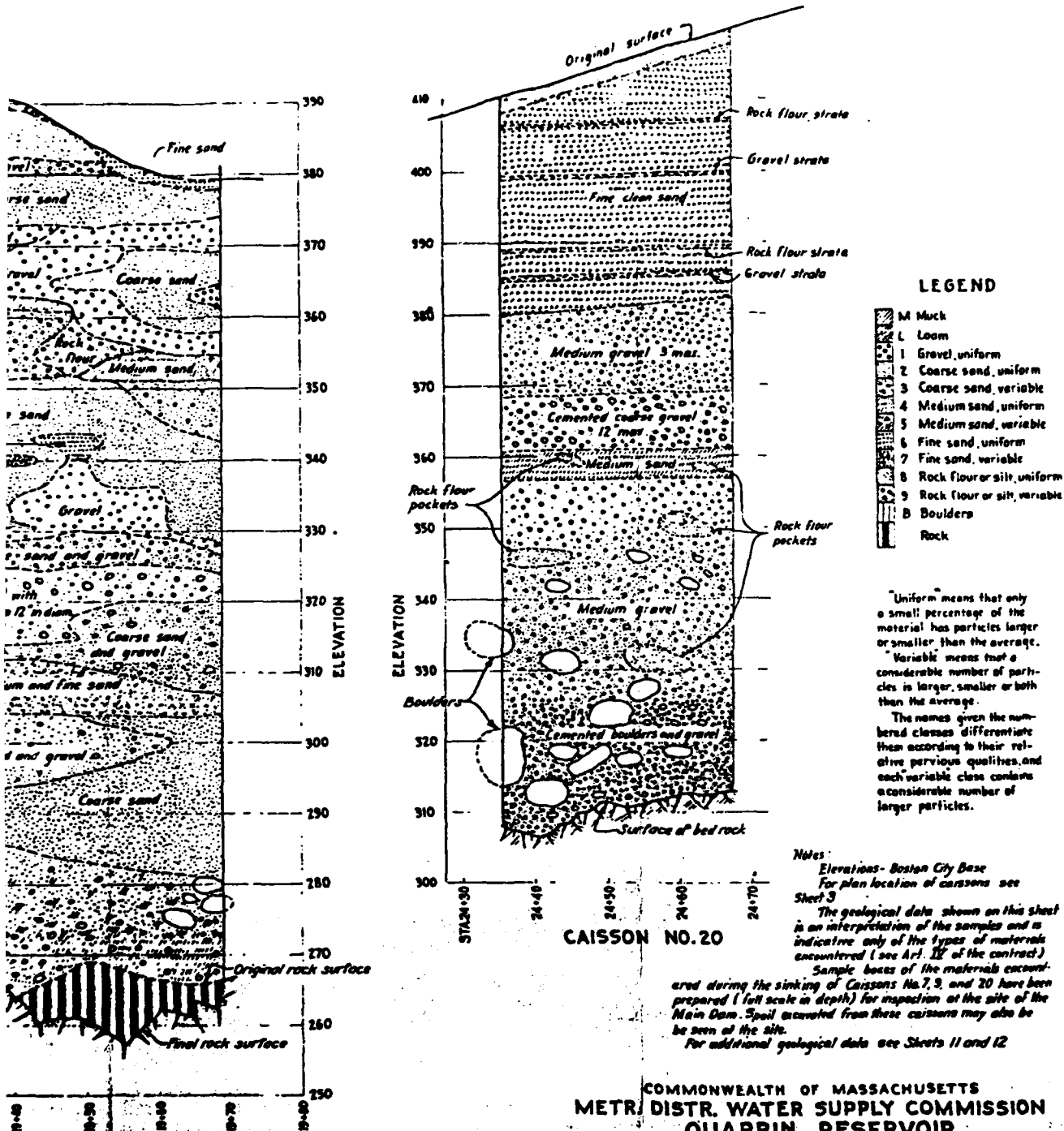


Drawn: P.M.P.S.E. 2-2
Traced: S.F.T.
Checked: J.F.S. 1-26

Frank R. Hume
Asst. Chief Engineer

Frank S. Hume
Chief Engineer

Charles W. Hume
Chief Engineer



COMMONWEALTH OF MASSACHUSETTS
METR. DIST. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
MAIN DAM CORE WALL
OVERBURDEN - GEOLOGICAL DATA - SHEET 3

DECEMBER 21, 1934

Act 4303

APPENDIX B-57

2

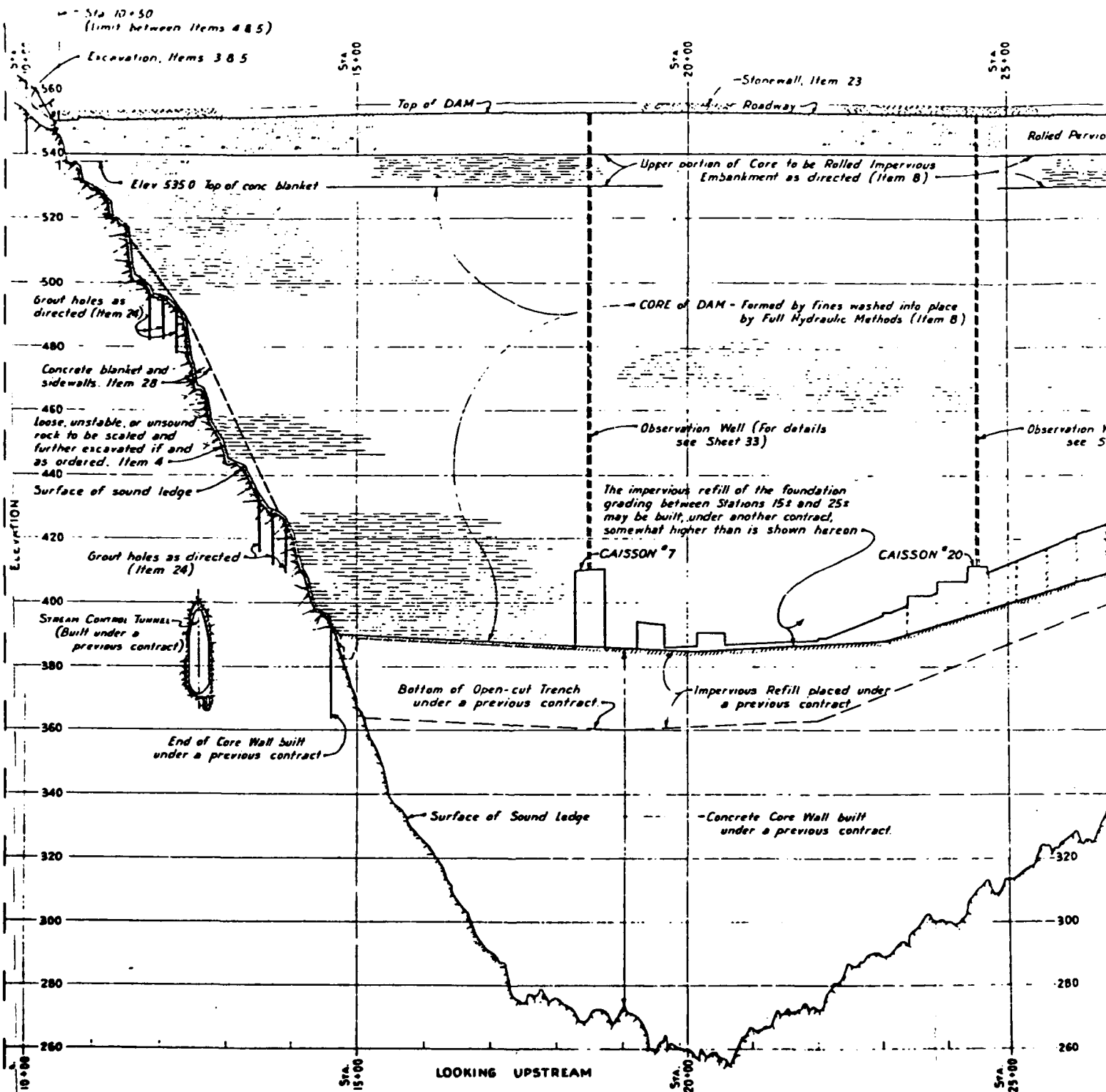
File 4160 B42

Designed *W.H.*
 Drawn *E.H.*
 Traced *E.H.*
 Checked *W.H.*

W.H.
 Asst Chief Engineer

W.H.
 Chief Engineer

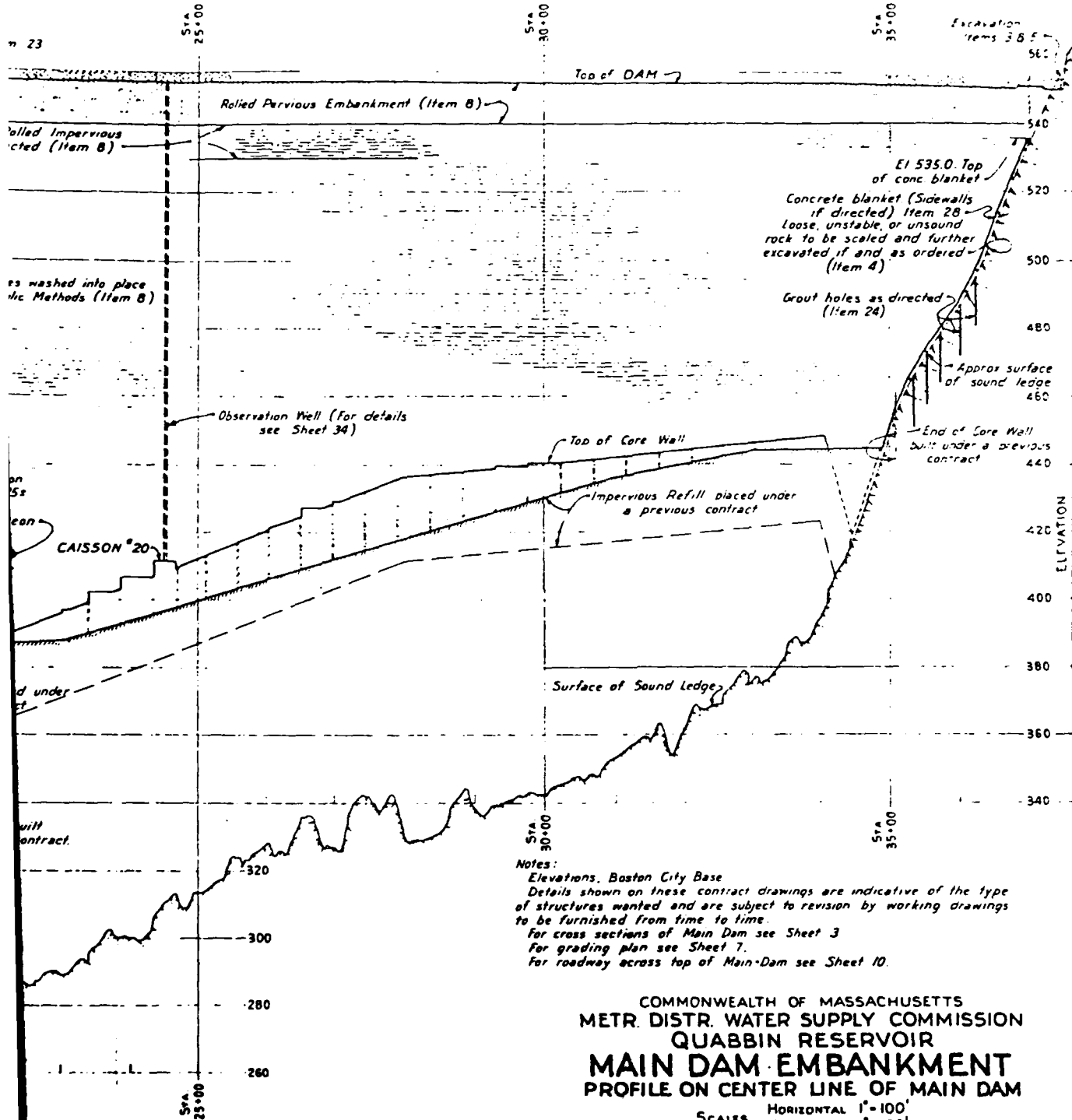
W.H.
 Consultant



70

CONTRACT 52 SHEET 4
36 SHEETS IN SET

Sta 31+00
(limit between Items 4 & 5)



COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
MAIN DAM EMBANKMENT
PROFILE ON CENTER LINE OF MAIN DAM

SCALES HORIZONTAL 1"=100'
VERTICAL 1"=20'

JUNE 1, 1936

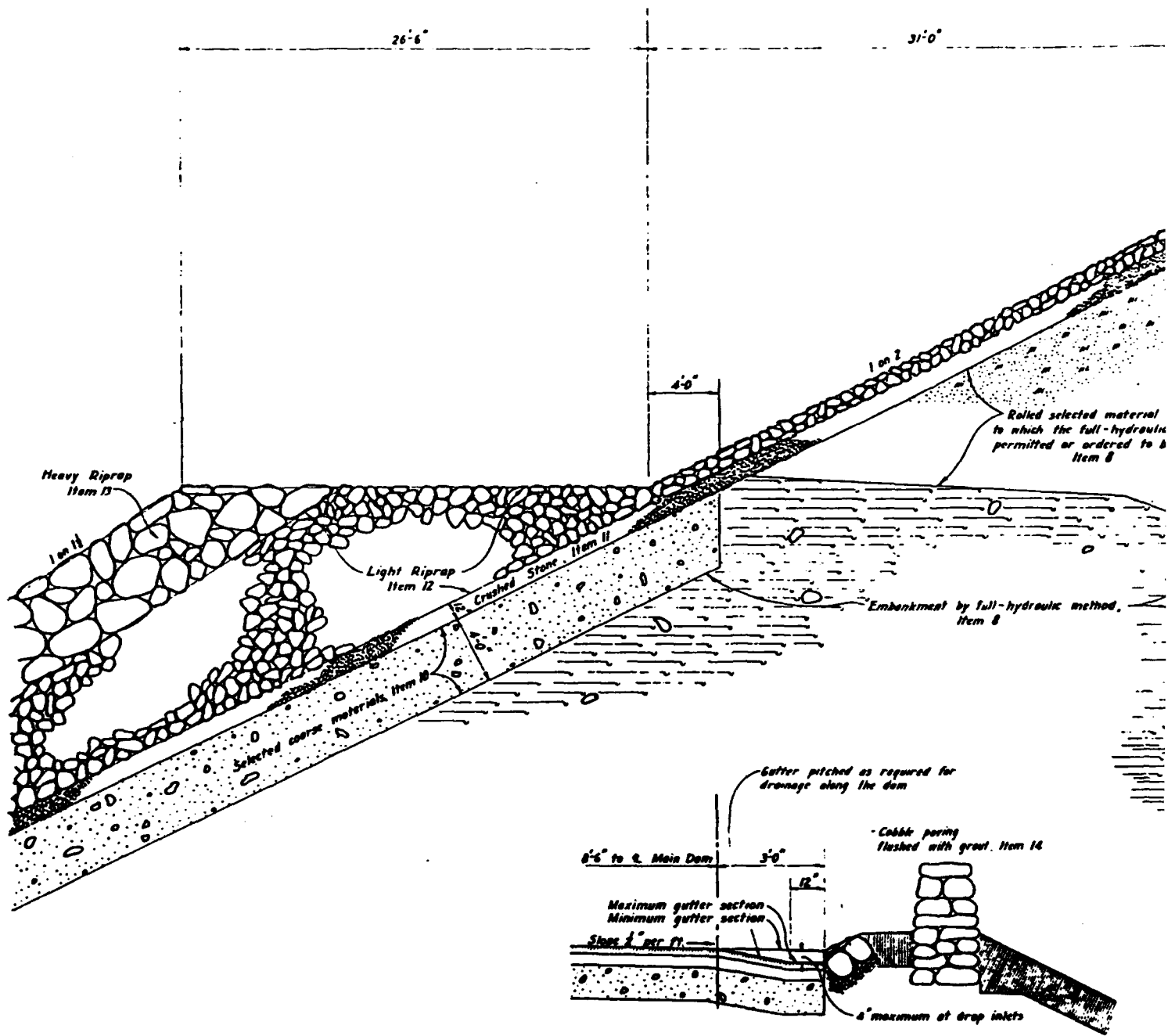
Charles J. Munn
Consulting Engineer

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Acc 74 106

APPENDIX B-58

2



DETAIL OF GUTTER

File 4160 B43

Designed: *[Signature]*
 Drawn: *[Signature]*
 Traced: *[Signature]*
 Checked: *[Signature]*

Frank H. Hamilton
 Asst. Chief Engineer

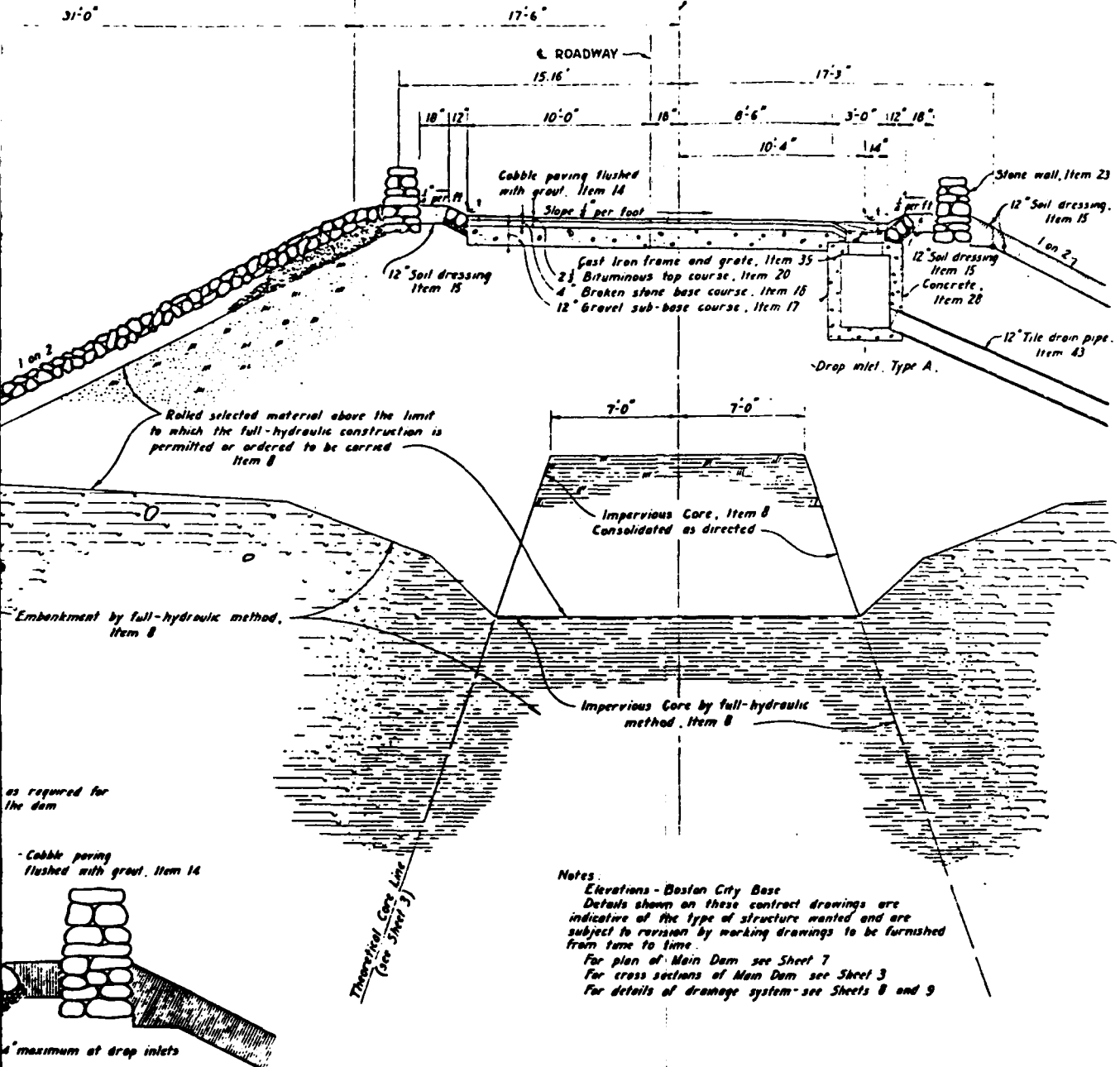
Frank H. Hamilton
 Chief Engineer

Charles
 Co.

①

CONTRACT 52 SHEET 10
36 SHEETS IN SET

€ MAIN DAM



Notes:
Elevations - Boston City Base
Details shown on these contract drawings are indicative of the type of structure wanted and are subject to revision by working drawings to be furnished from time to time.
For plan of Main Dam see Sheet 7
For cross sections of Main Dam see Sheet 3
For details of drainage system see Sheets 8 and 9

COMMONWEALTH OF MASSACHUSETTS
METR. DIST. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
MAIN DAM EMBANKMENT
CROSS SECTION OF TOP OF MAIN DAM



EXCEPT AS NOTED
JUNE 1, 1936

⑥

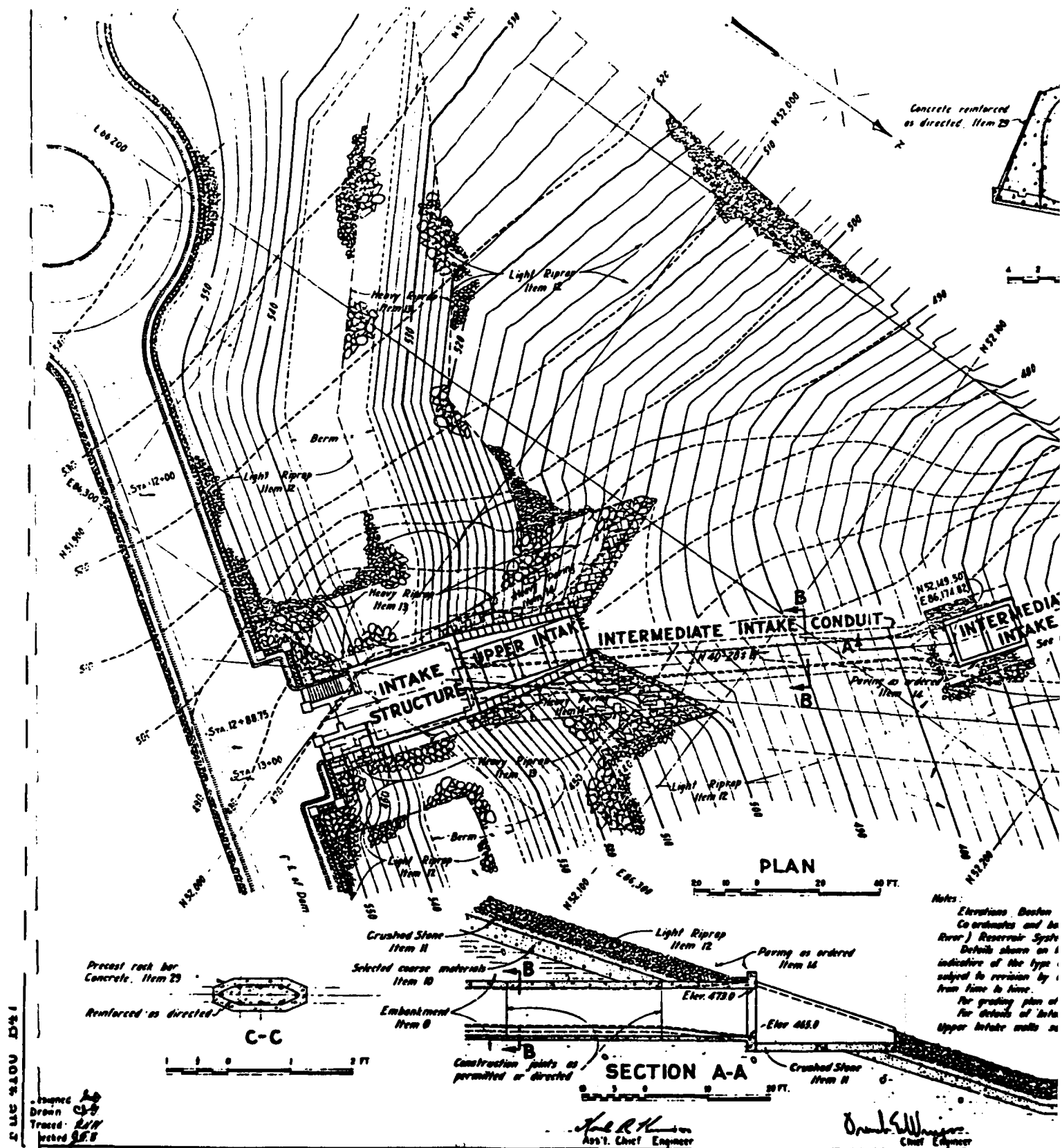
Charles T. Main
Consulting Engineer

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Ass 24.110

APPENDIX B-59

②

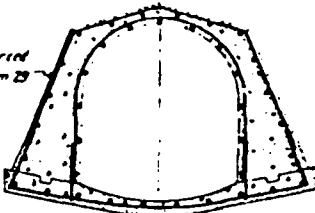


NOT A J

Assigned 24
Drawn 49
Traced 217
Indexed 958

6

Concrete reinforced
as directed, Item 25

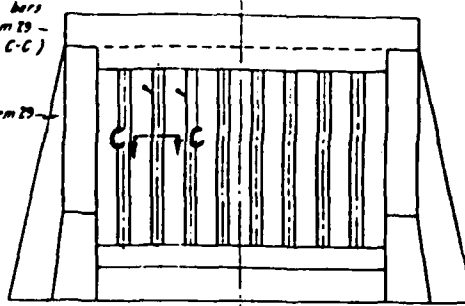


B-B

4 2 0 4 8 FT.

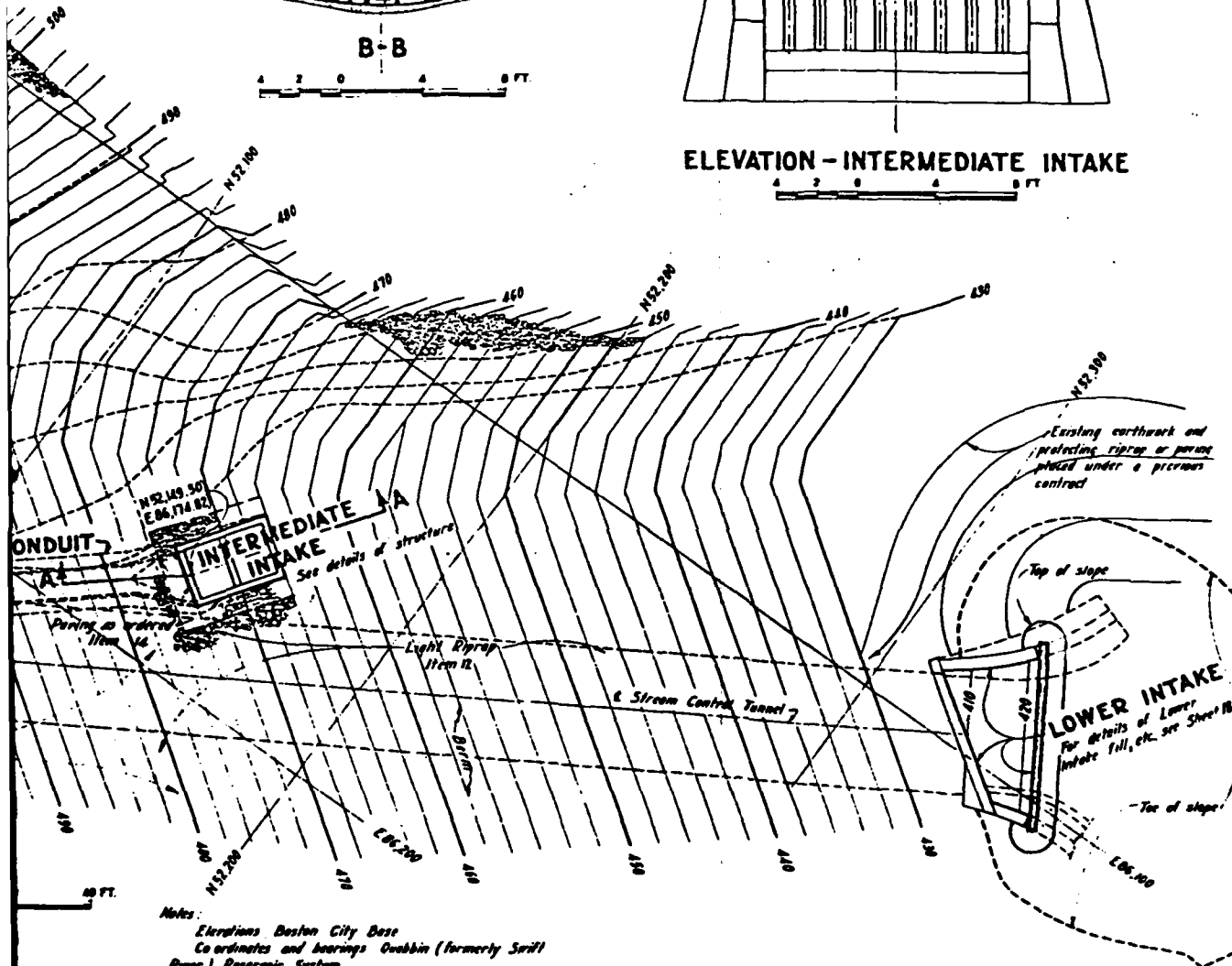
Precast rock bars
Concrete, Item 25 -
(See Section C-C)

Concrete, Item 25



ELEVATION - INTERMEDIATE INTAKE

4 2 0 4 8 FT.



Notes:
Elevations Boston City Base
Coordinates and bearings Quabbin (formerly Swift)
River) Reservoir System.
Details shown on these contract drawings are
indicative of the type of structure wanted and are
subject to revision by working drawings to be furnished
from time to time.
For grading plan of Main Dam see Sheet 7
For details of Intake Works Substructure and
Upper Intake walls see Sheets 19 to 27 incl.

COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
MAIN DAM EMBANKMENT
INTAKE WORKS-INTAKES

SCALES AS SHOWN

JUNE 1, 1936

Frank E. Williams
Chief Engineer

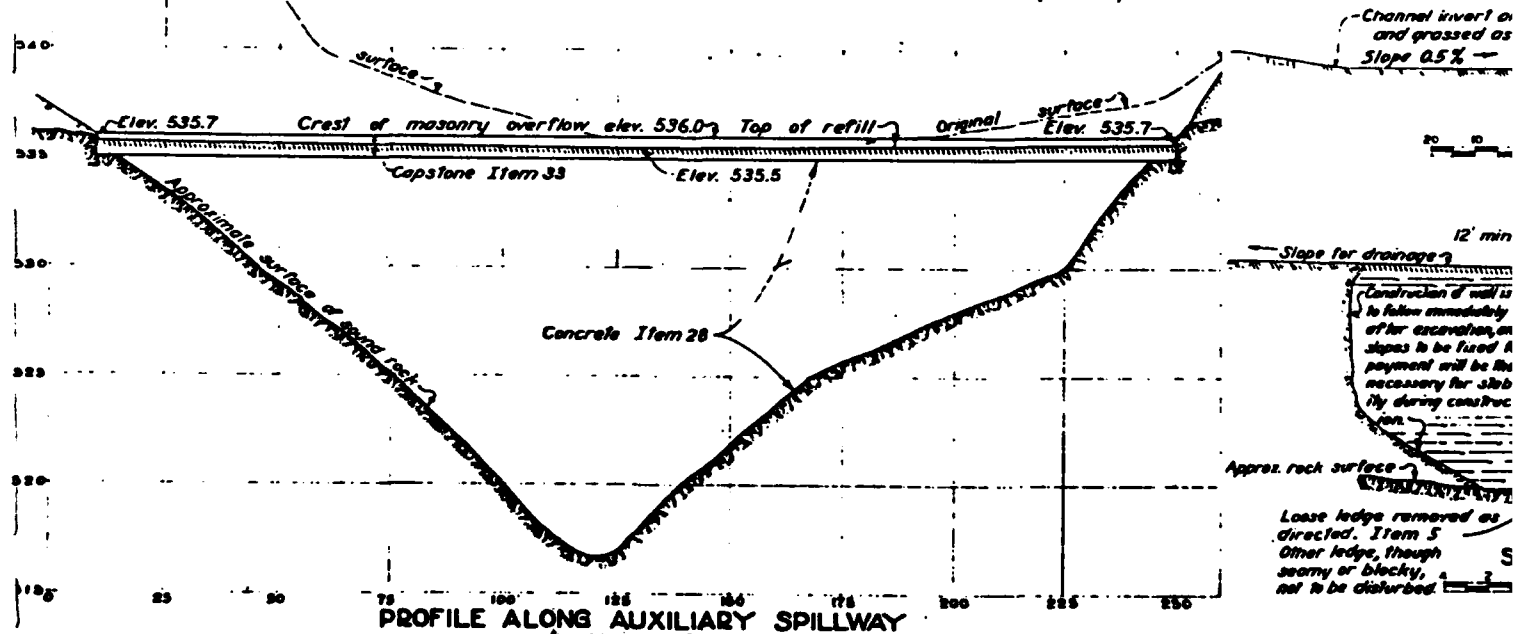
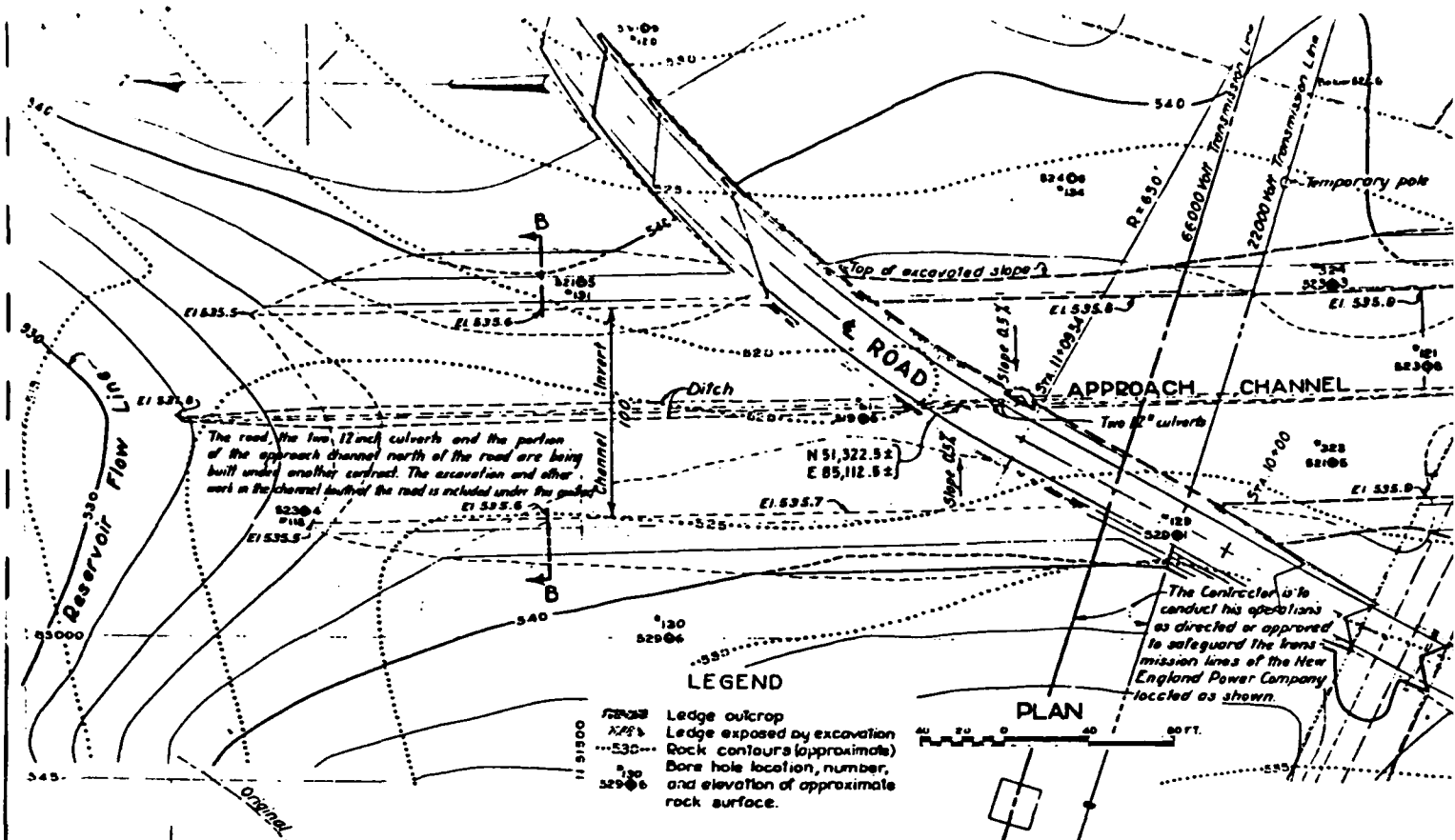
Charles F. Main
Consulting Engineer

FILE CONT. 52-2.32 5

Acc 24, 117

17

2

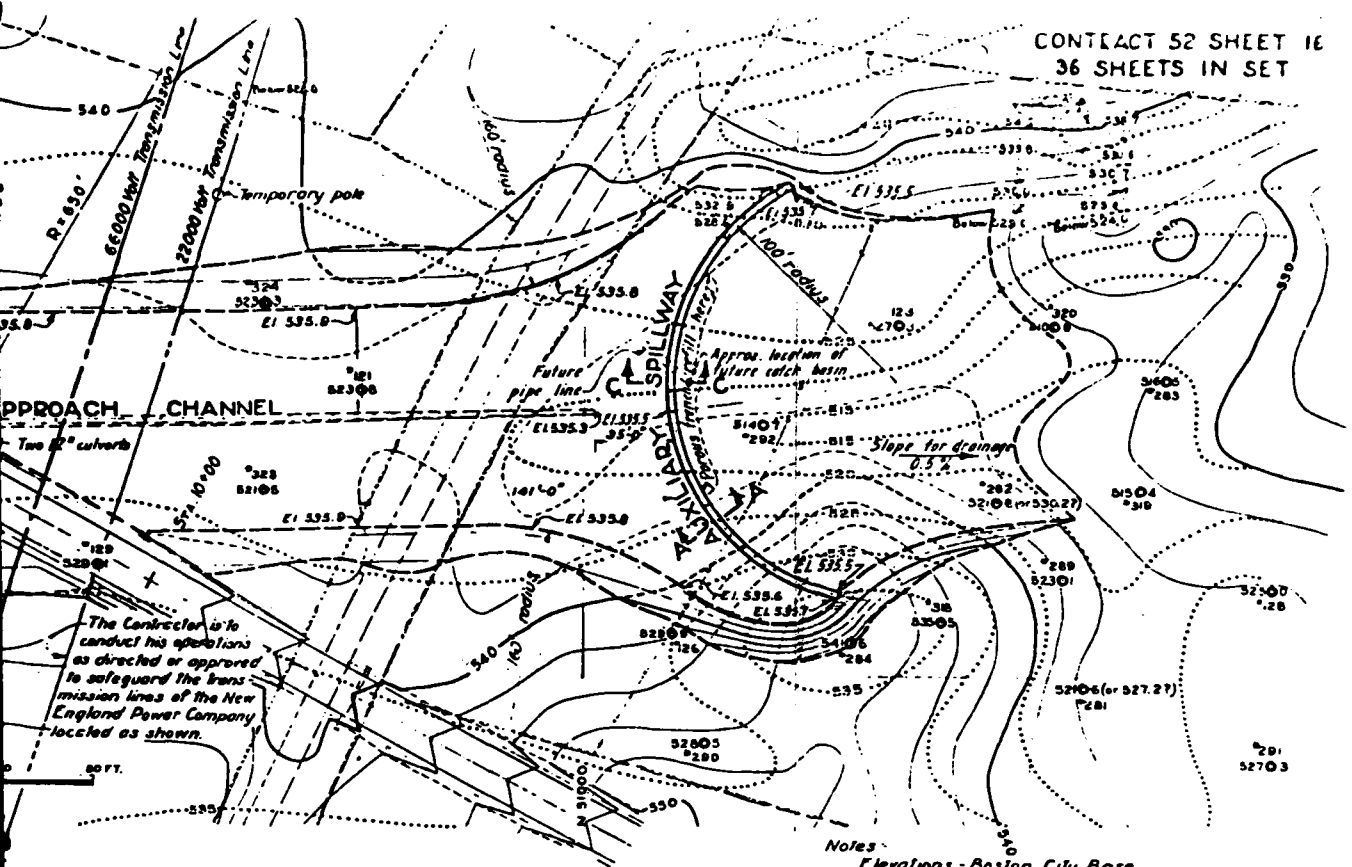


Designed by
Brown, 1931
Traced 1931
Checked ASB 1938

Paul P. Hammon
Asst. Chief Engineer

Jack E. Williams
Chief Engineer

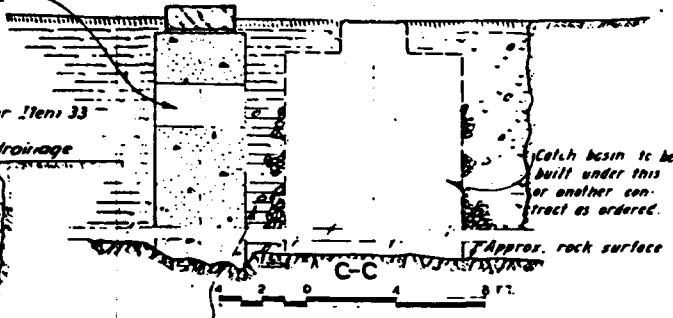
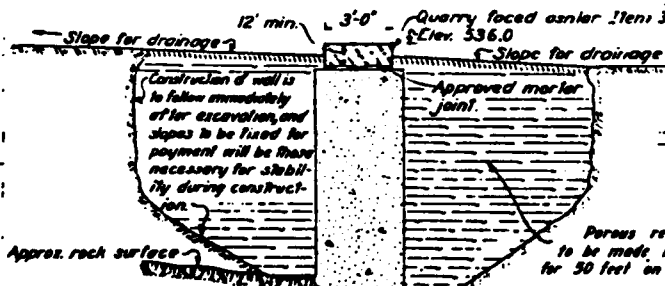
Charles J. M.
Consulting



Channel invert and slopes dressed with topsoil and grassed as directed. Item 15
Slope 0.5% — Ditch — Slope 0.5% 1 on 6 1/2

Opening for pipe line to be left if directed
B-B
20 0 20 40 FT.

Notes
Elevations - Boston City Base
Coordinates and bearings, Quabbin (formerly Swift River) Reservoir System.
Details shown on these contract drawings are indicative of the type of structures wanted and are subject to revision by working drawings to be furnished from time to time.
For general plan showing location of auxiliary spillway see Sheet 2



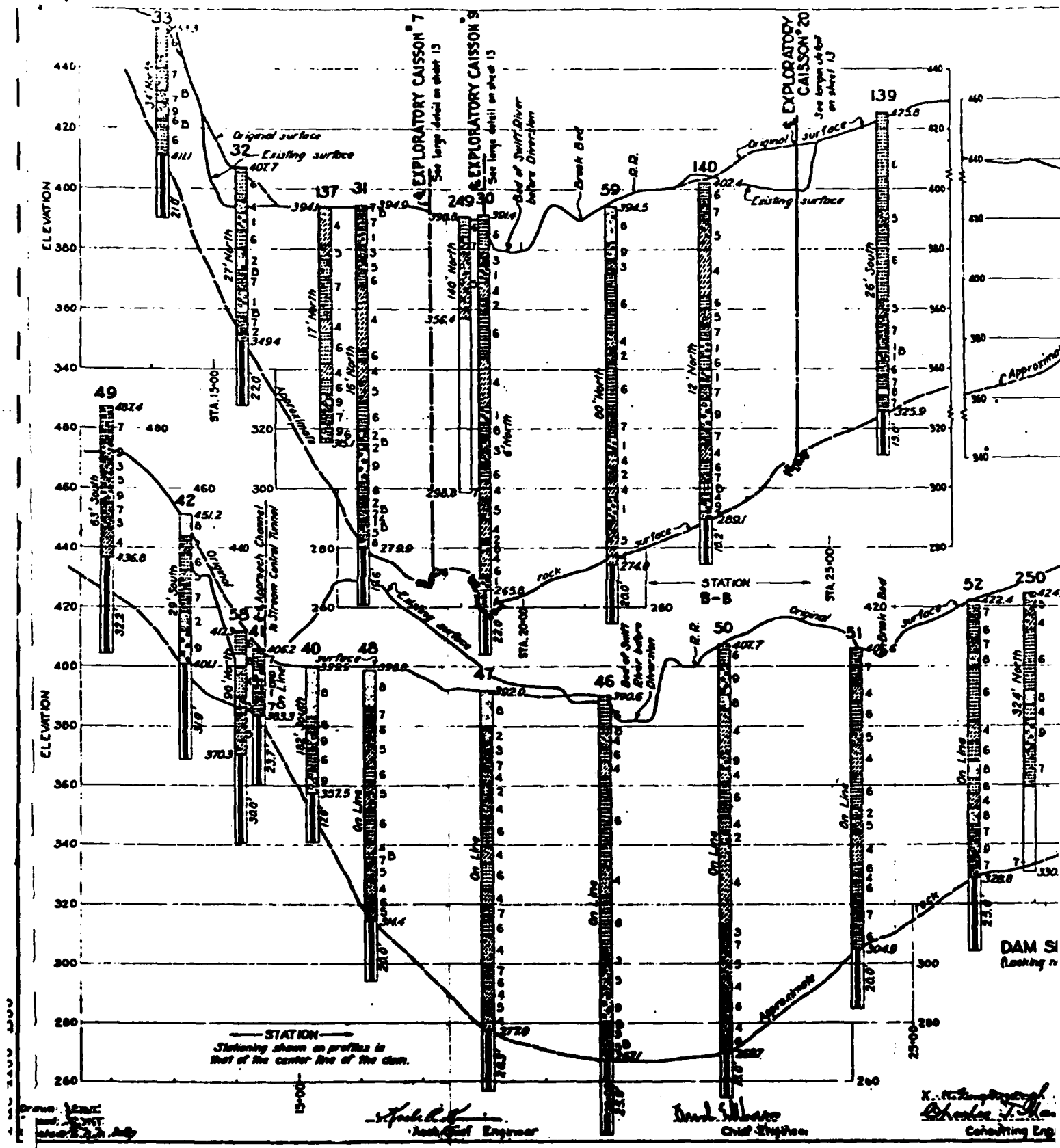
COMMONWEALTH OF MASSACHUSETTS
METR. DIST. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
**MAIN DAM EMBANKMENT
AUXILIARY SPILLWAY**
SCALES AS NOTED

JUNE 1, 1936

Charles T. Main
Consulting Engineer

FILE CONT. 52-2,328

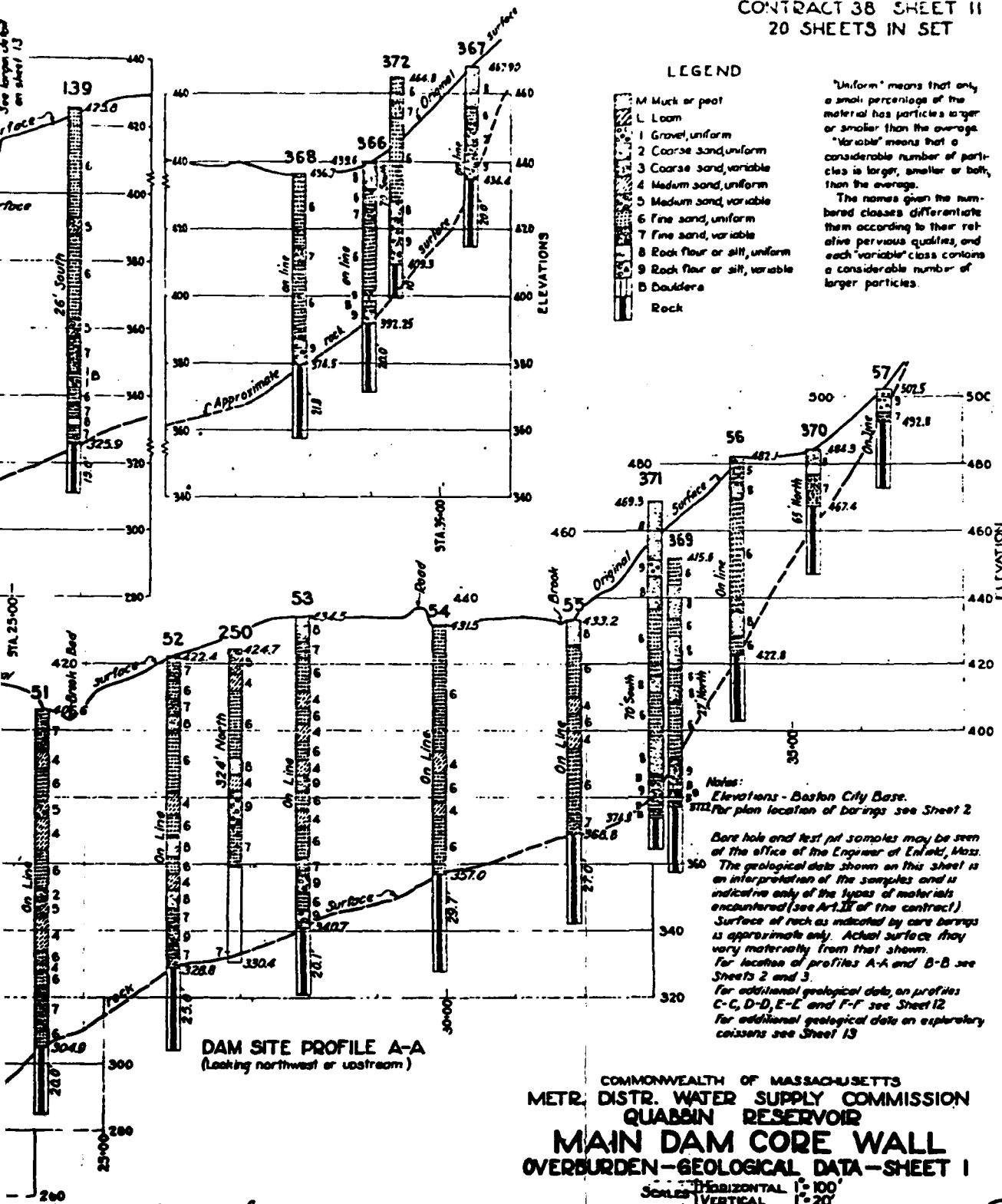
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LEGEND

- M Muck or peat
- L Loam
- 1 Gravel, uniform
- 2 Coarse sand, uniform
- 3 Coarse sand, variable
- 4 Medium sand, uniform
- 5 Medium sand, variable
- 6 Fine sand, uniform
- 7 Fine sand, variable
- 8 Rock flour or silt, uniform
- 9 Rock flour or silt, variable
- B Boulders
- Rock

"Uniform" means that only a small percentage of the material has particles larger or smaller than the average.
"Variable" means that a considerable number of particles is larger, smaller or both, than the average.
The names given the numbered classes differentiate them according to their relative pervious qualities, and each "variable" class contains a considerable number of larger particles.



COMMONWEALTH OF MASSACHUSETTS
METR. DIST. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
MAIN DAM CORE WALL
OVERBURDEN—GEOLOGICAL DATA—SHEET 1

HORIZONTAL 1"=100'
VERTICAL 1"=20'
DECEMBER 21, 1934

X. Thompson
Charles T. Mann
Consulting Engineers

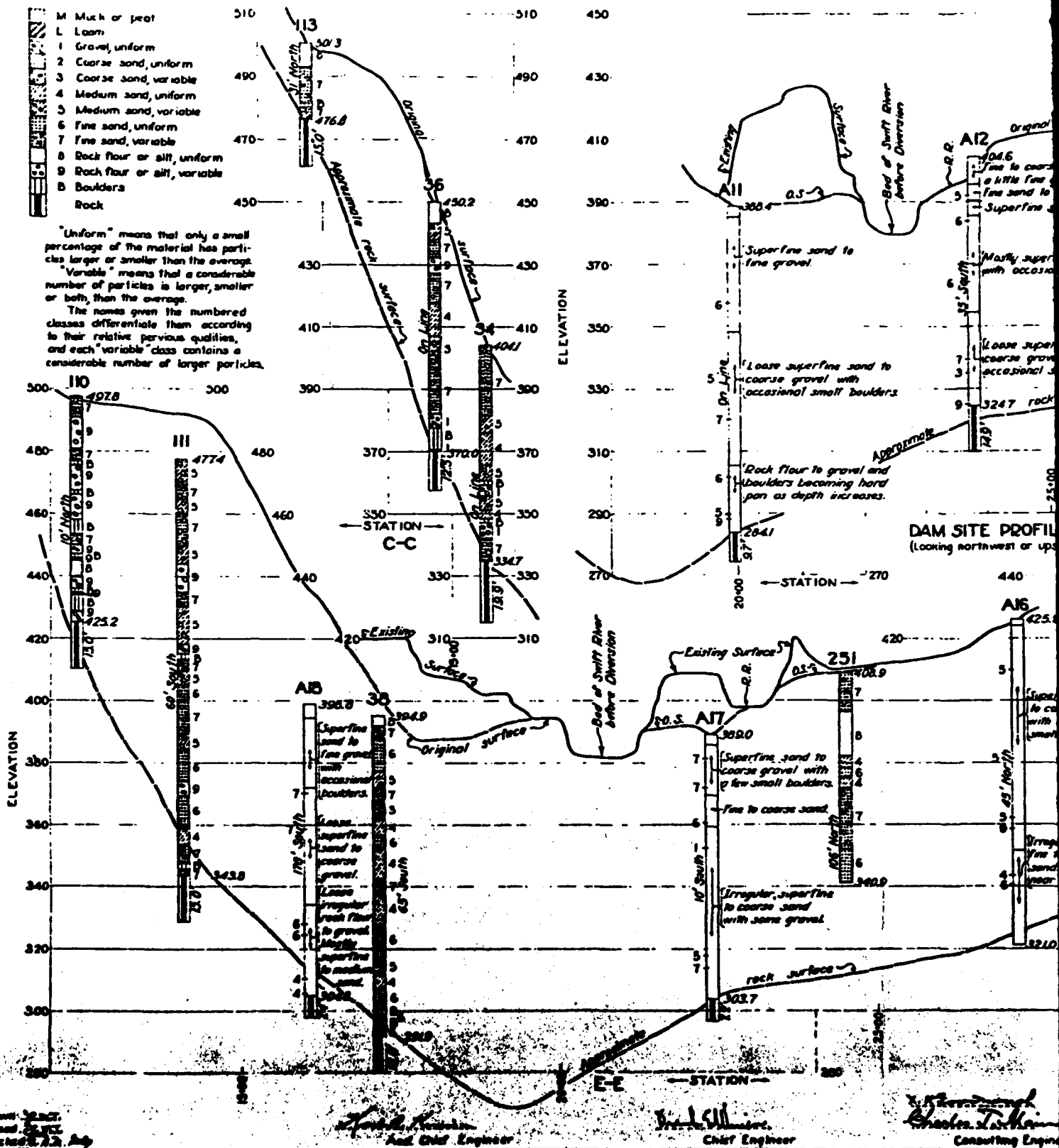
File 38-2323

11
12
13
14
15
16
17
18
19
20

LEGEND

- M Muck or peat
- L Loom
- 1 Gravel, uniform
- 2 Coarse sand, uniform
- 3 Coarse sand, variable
- 4 Medium sand, uniform
- 5 Medium sand, variable
- 6 Fine sand, uniform
- 7 Fine sand, variable
- 8 Rock flour or silt, uniform
- 9 Rock flour or silt, variable
- B Boulders
- Rock

"Uniform" means that only a small percentage of the material has particles larger or smaller than the average.
 "Variable" means that a considerable number of particles is larger, smaller or both, than the average.
 The names given the numbered classes differentiate them according to their relative pervious qualities, and each "variable" class contains a considerable number of larger particles.



DAM SITE PROFILE
 (Looking northwest of upstream)

J. L. Hill, Chief Engineer

Charles T. Hill, Consulting Engineer

Charles T. Hill, Consulting Engineer





FILE 1000-B38

CONTRACT 50 SHEET 2
15 SHEETS IN SET

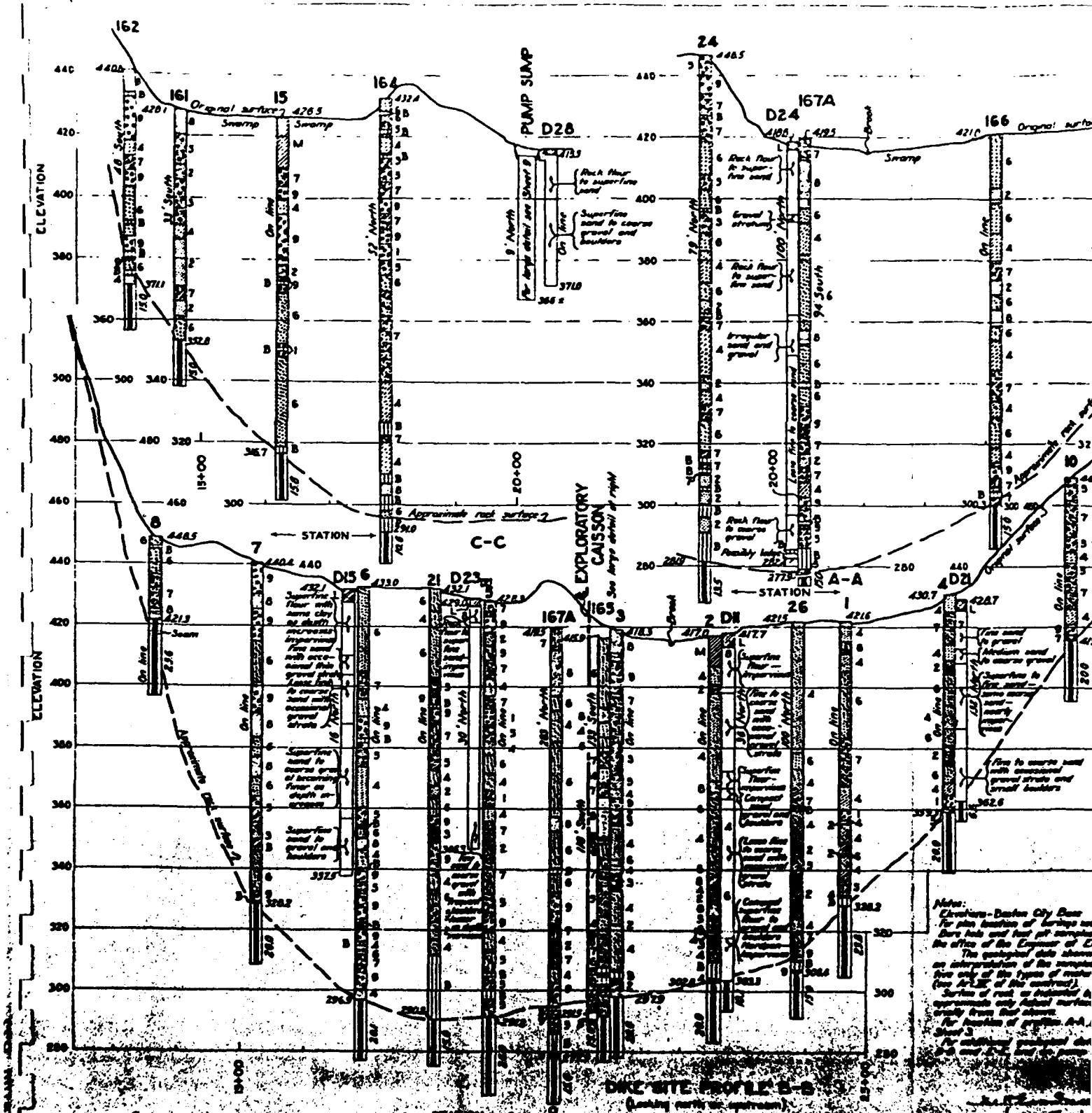
Notes
Elevations - Boston City Base
Coordinates and bearings - Swift River
(now Quabbin) Reservoir System
For plan, profile and cross sections of
dike embankment see Sheets 3 & 4 and 10
and for details of roads see Sheets 10 and 13
Preliminary investigations indicate suitable
materials may be found for Items 5, 6, 7, 8
and 15 in the "Permitted Borrow Areas"
except as noted, but the Contractor will be
allowed to borrow from any permitted areas
only to the extent that the materials are
satisfactory for their intended use.
In addition, impervious soil may be obtained
from areas which will be designated north-
westerly of the dike near the Enfield-Ware
road.
The existence of or a sufficiency of suit-
able materials for Item 8 or any other item
in any one borrow area shown is not guaran-
teed.

Note: Records of investigations of borrow
pit materials may be seen at the office of the Engineer

COMMONWEALTH OF MASSACHUSETTS

COMMONWEALTH OF MASSACHUSETTS
METR. DIST. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
DIKE EMBANKMENT
GENERAL PLAN

2



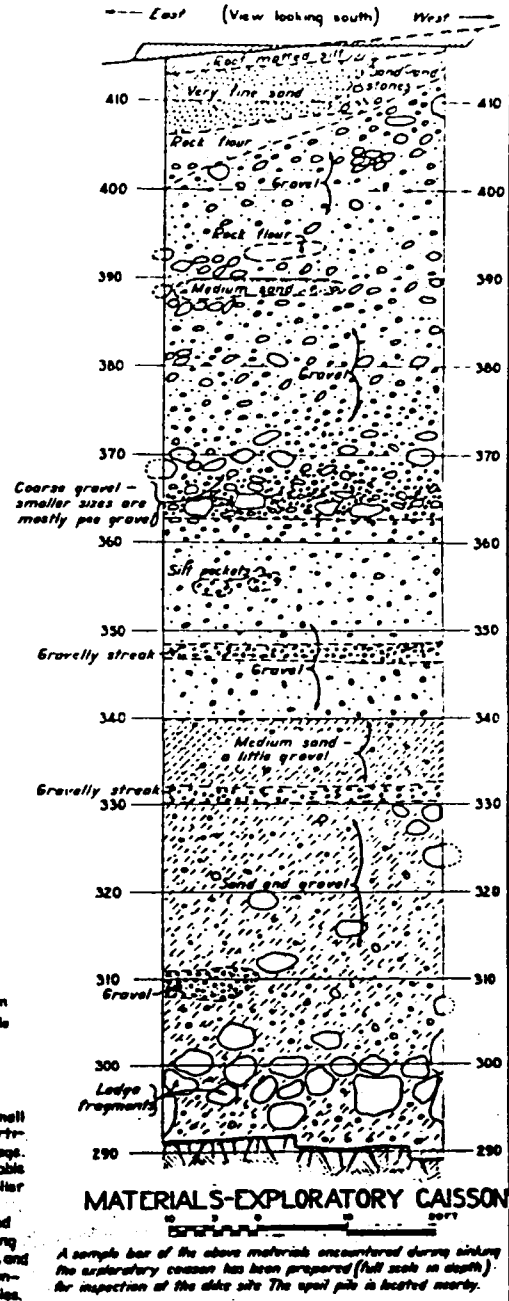
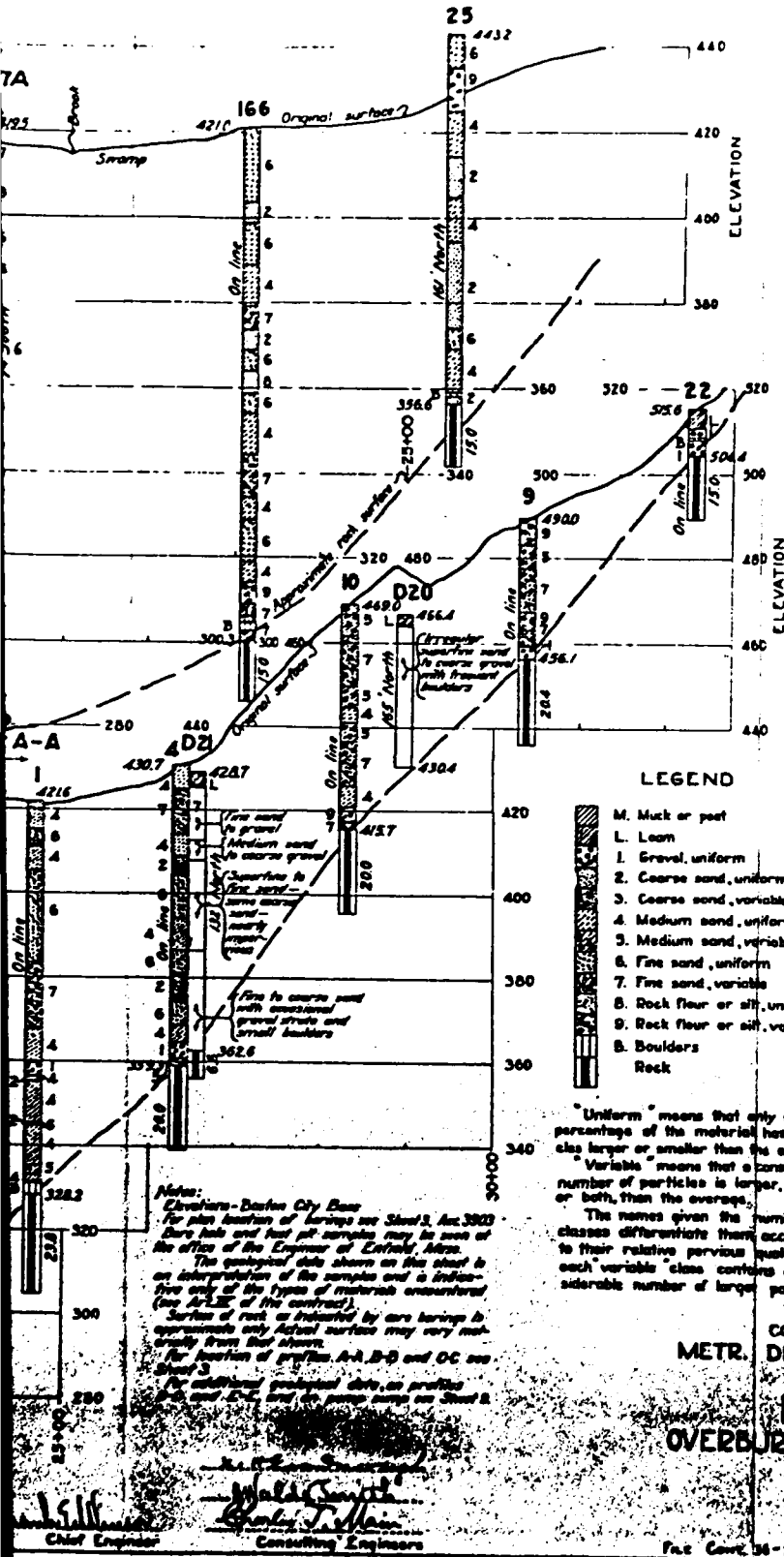
Notes:
 Elevations-Dallas City Base
 For plan location of borings see
 DNE hole and test pit surveys
 the office of the Engineer of C.
 The geological data shows
 an interpretation of the samples
 from only of the types of notes
 (see A-A of this contract).
 Series of test or indicators to
 approximate only actual surface
 grade from that shown.
 For location of profile A-A,
 Sheet 3.
 For additional geological data
 see A-A, and DNE hole and test pit
 surveys.

Designed by *[Signature]*
 Drawn by *[Signature]*
 Checked by *[Signature]*

Stationing shown at profile is
 that of the center line of the site

[Signature] Designing Engineer
[Signature] Chief Engineer
[Signature] Consulting Engineer

CONTRACT 36 SHEET 8
14 SHEETS IN SET

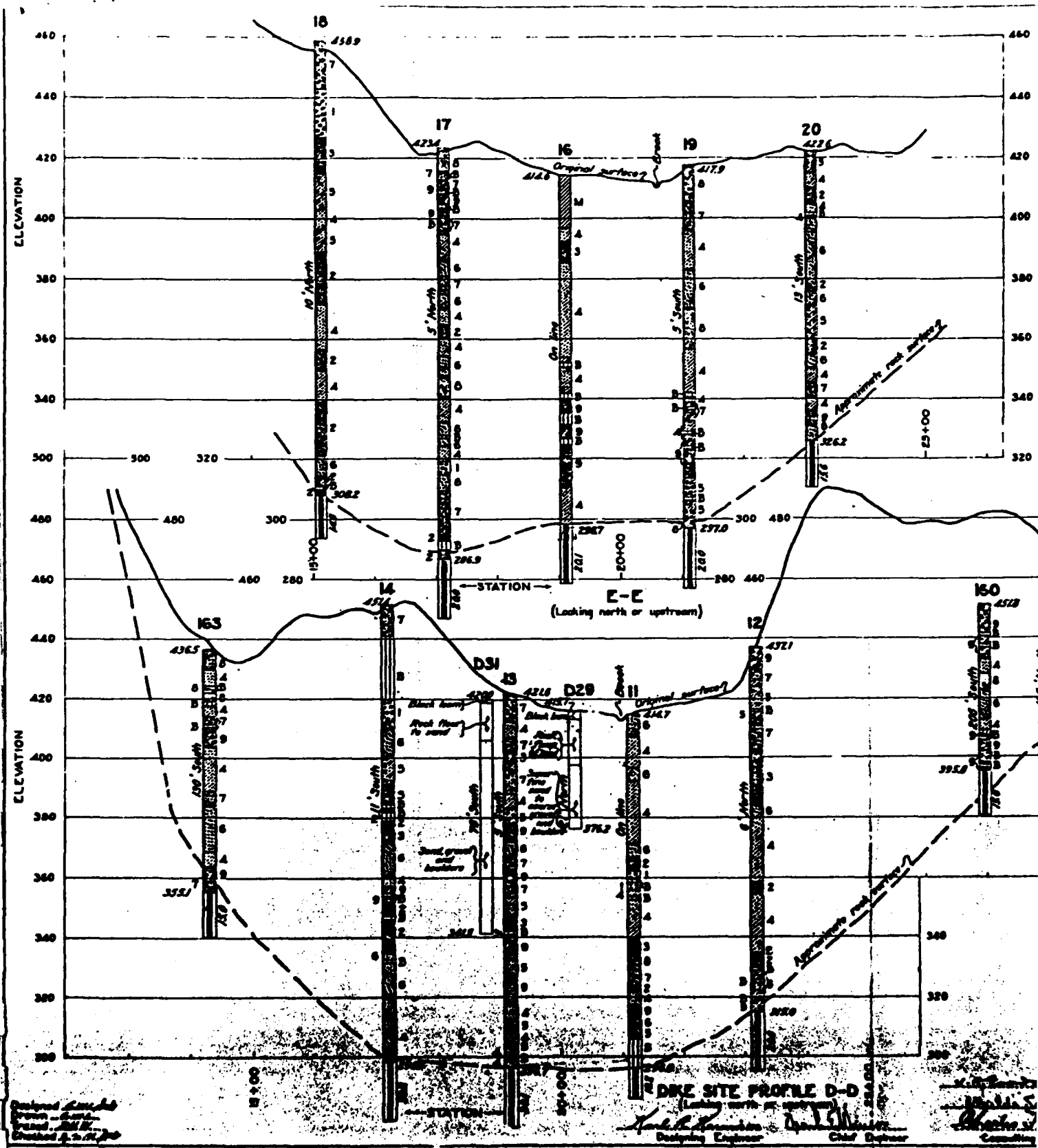


COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
DIKE CORE WALL
OVERBURDEN-GEOLOGICAL DATA-SHEET 1

SCALE: HORIZONTAL 1"=100'
VERTICAL 1"=20'
EXCEPT AS NOTED
NOVEMBER 4, 1932



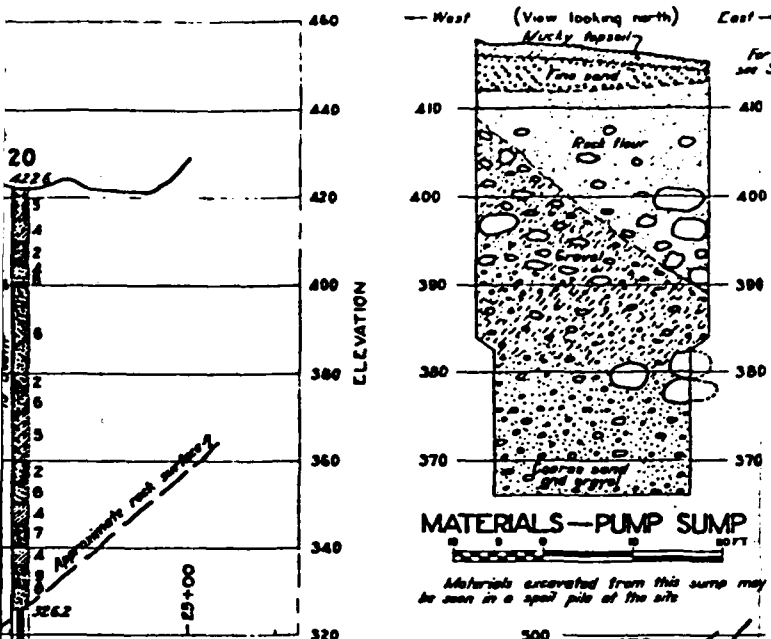
File 100-2-200



Designed by *[Signature]*
Drawn by *[Signature]*
Checked by *[Signature]*

[Signature] Designing Engineer
[Signature] Chief Engineer
[Signature] Consulting

CONTRACT 36 SHEET 9
14 SHEETS IN SET



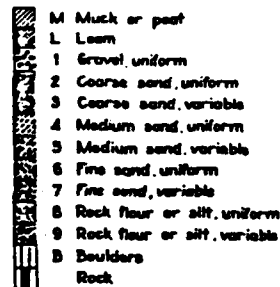
MATERIALS - PUMP SUMP

Materials excavated from this sump may be seen in a spoil pile at the site.

For location in profile see Sheet 8 Section C-C

Notes:
Elevations - Boston City Base
For plan location of borings see Sheet 3 Acc. 3903
Bore logs and test pit samples may be seen at the office of the Engineer at Enfield, Mass.
The geological data shown on this sheet is an interpretation of the samples and is indicative only of the types of materials encountered (see Art. XX of the contract).
Surfaces of rock as indicated by core borings is approximate only. Actual surfaces may vary materially from that shown.
Stationing shown on profiles is that of the center line of the dike.
For location of profiles D-D and E-E see Sheet 3
For additional geological data, on profiles A-A, B-B and C-C, and an exploratory canon, see Sheet 8

LEGEND

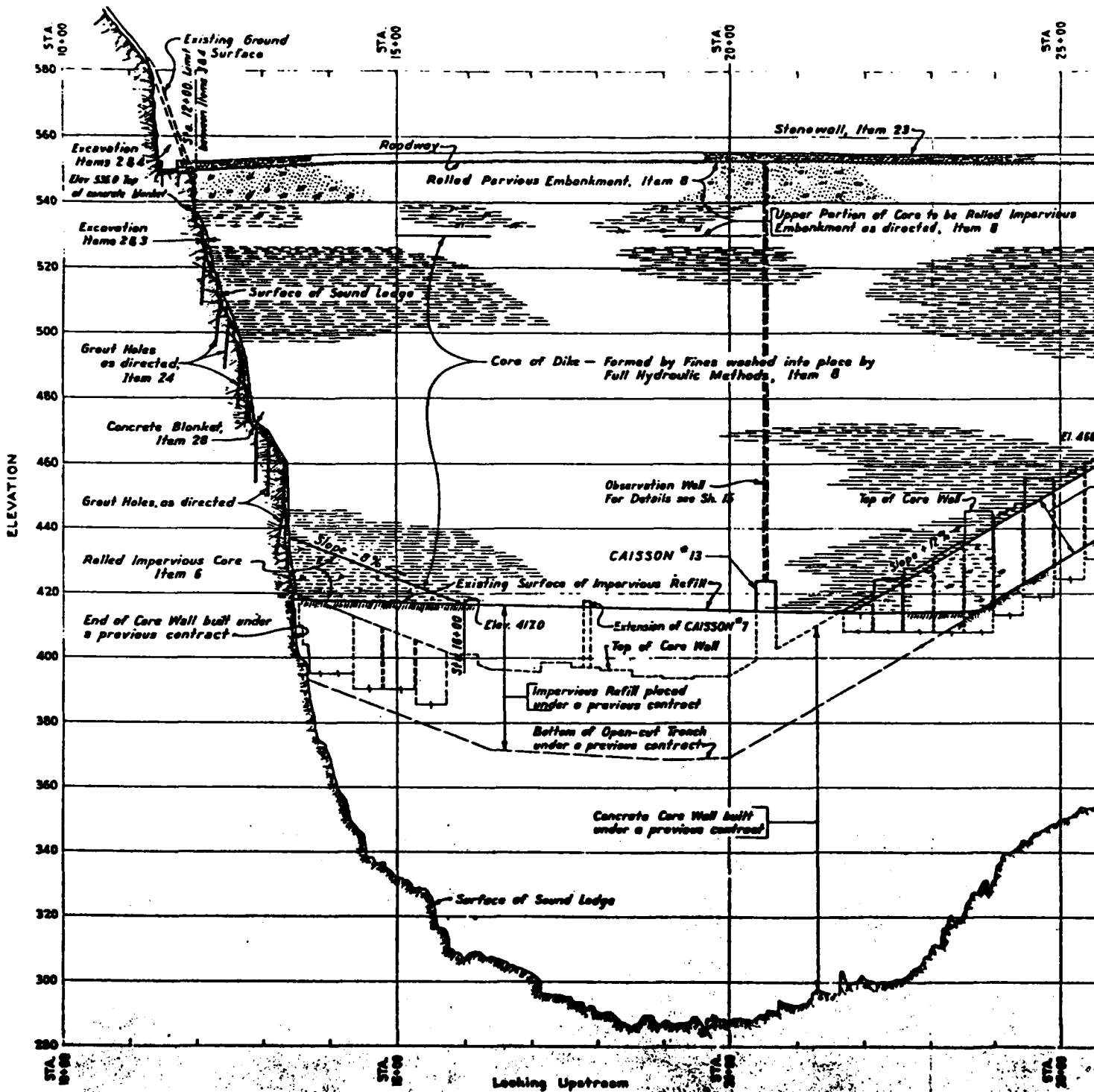


"Uniform" means that only a small percentage of the material has particles larger or smaller than the average.
"Variable" means that a considerable number of particles is larger, smaller or both, than the average.
The names given the numbered classes differentiate them according to their relative pervious qualities, and each "variable" class contains a considerable number of larger particles.

COMMONWEALTH OF MASSACHUSETTS
METR. DIST. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
DIKE CORE WALL
OVERBURDEN - GEOLOGICAL DATA - SHEET 2

SCALES (HORIZONTAL) 1" = 100'
(VERTICAL) 1" = 20'
EXCEPT AS NOTED
NOVEMBER 4, 1932





File 4160-B40

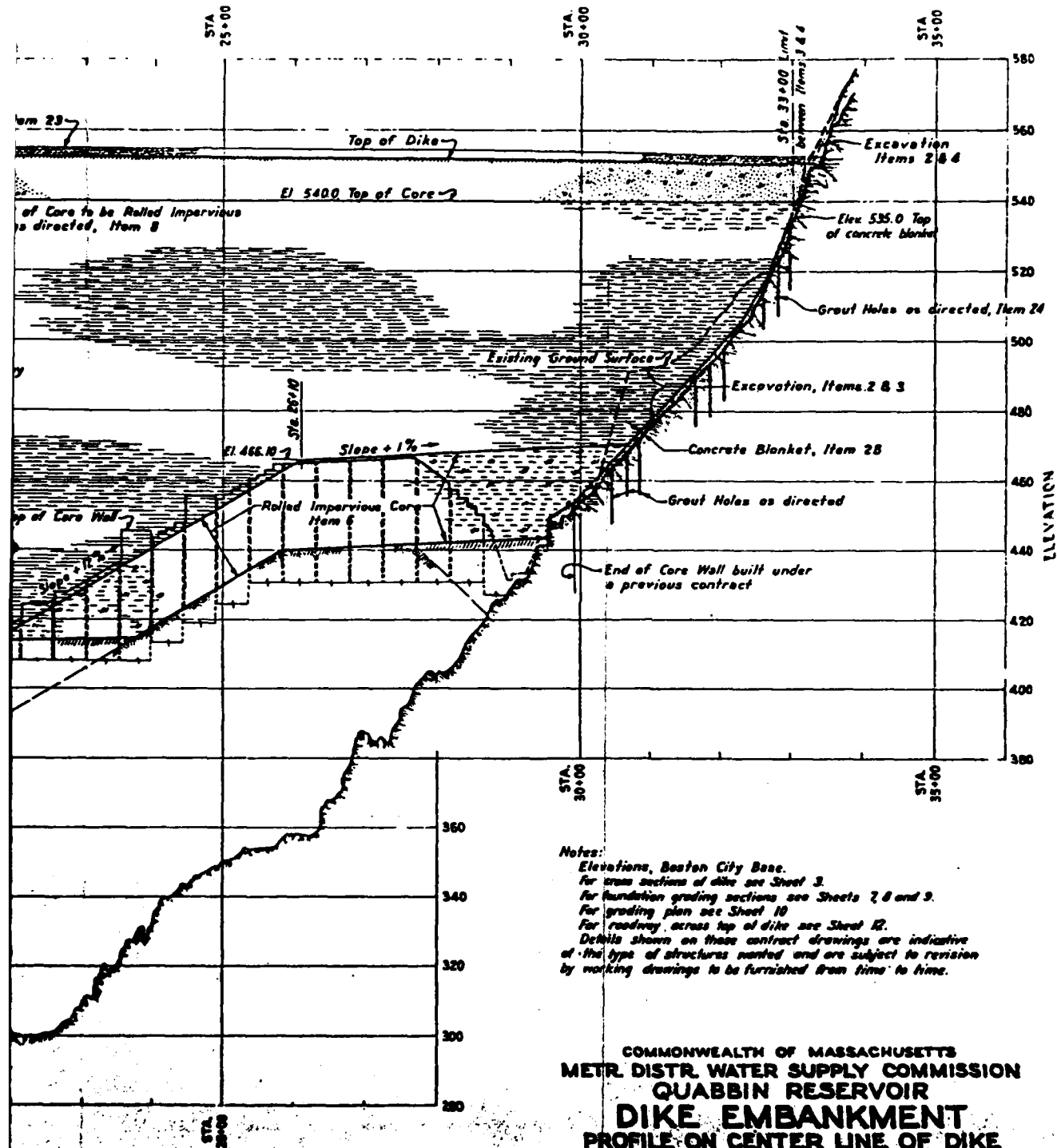
Designed by J. H. H. H.
Drawn by J. H. H. H.
Checked by J. H. H. H.

John H. H. H.
Asst. Chief Engineer

John H. H. H.
Chief Engineer

John H. H. H.
Comd.

CONTRACT 50 SHEET 4
15 SHEETS IN SET



Notes:

Elevations, Boston City Base.
For cross sections of dike see Sheet 3.
For foundation grading sections see Sheets 7, 8 and 9.
For grading plan see Sheet 10.
For roadway across top of dike see Sheet 12.
Details shown on these contract drawings are indicative of the type of structures wanted and are subject to revision by working drawings to be furnished from time to time.

COMMONWEALTH OF MASSACHUSETTS
METR. DIST. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
DIKE EMBANKMENT
PROFILE ON CENTER LINE OF DIKE

Scale (Horizontal 1" = 100'
Vertical 1" = 20')

OCTOBER 1, 1934

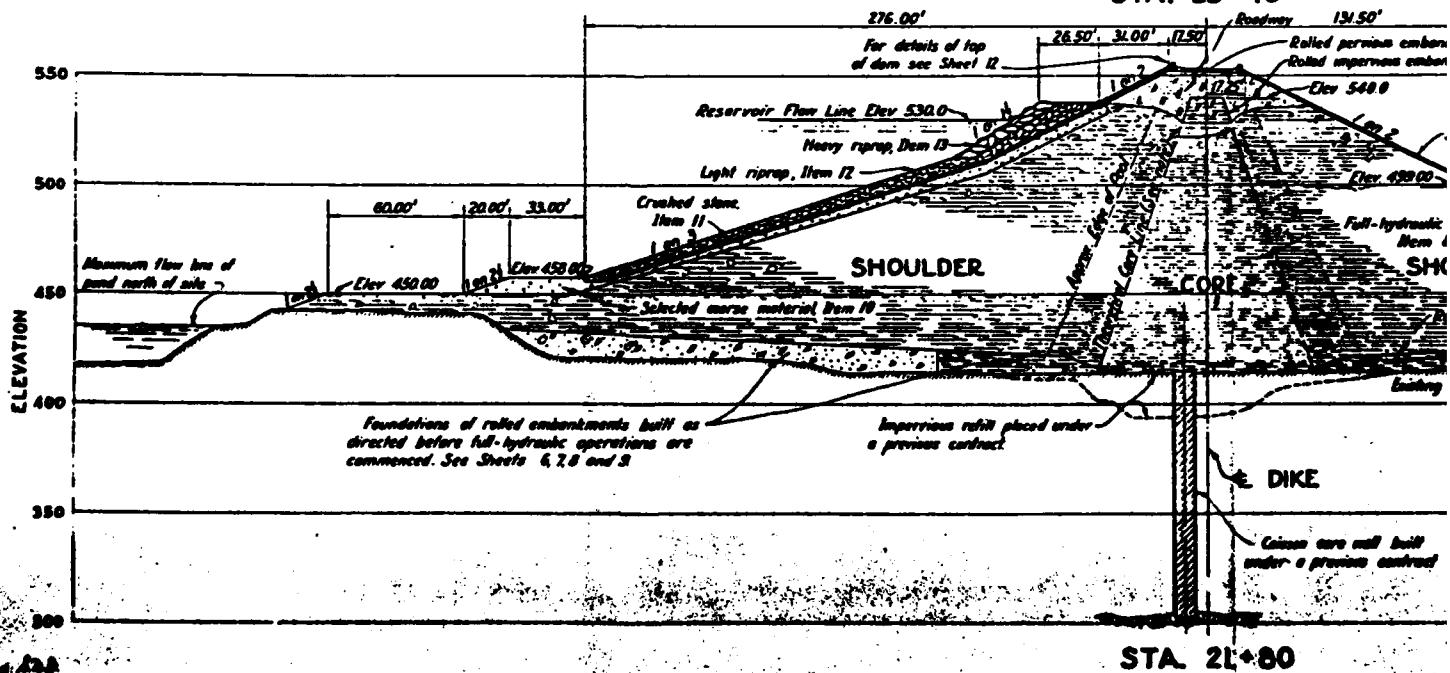
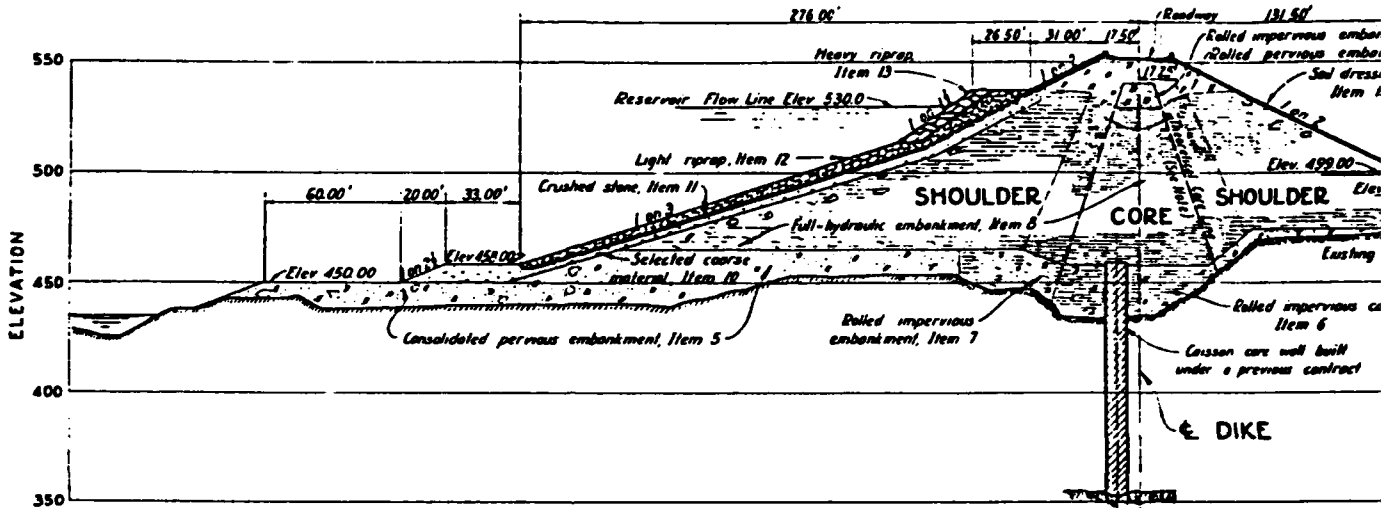
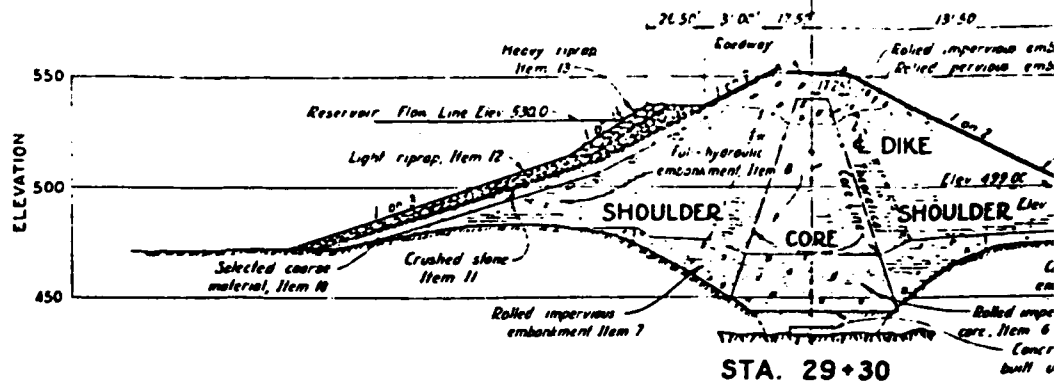
Charles L. Allen
Consulting Engineers

Proj. Cont. 50, 2, 21, 2

Acc. 45944

APPENDIX B-67

②



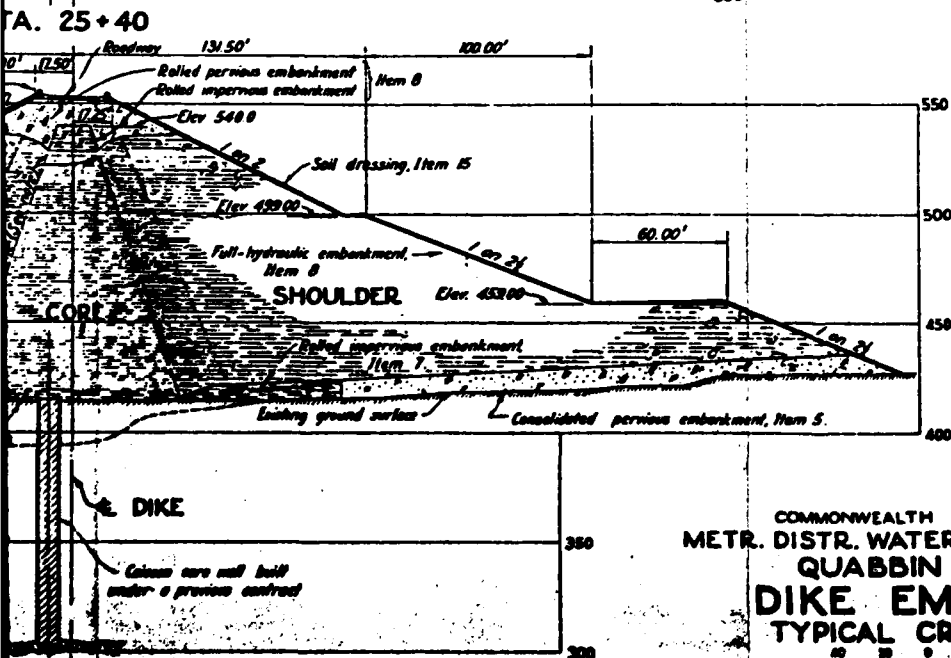
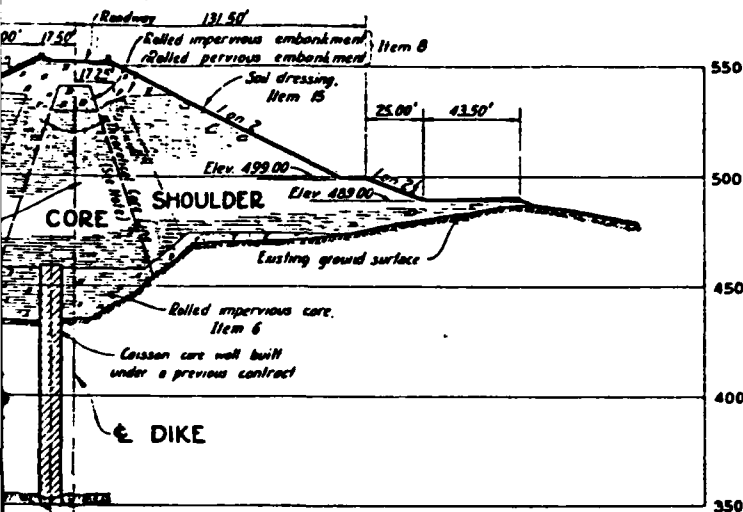
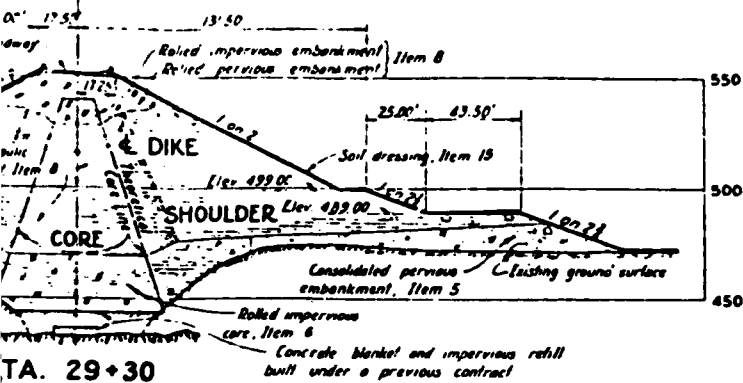
Designed by
Drawn by
Checked by
Scale 1" = 20'

Paul R. Hamilton
Chief Engineer

Paul S. Miller
Chief Engineer

John
Blair

CONTRACT 50 SHEET 3
15 SHEETS IN SET



Note:
The lines marked "Theoretical Core Line" indicate the desired width of cutoff of satisfactory, impervious quality and show the approximate location for the finest materials deposited by the hydraulic work under Item 8.

Notes
Elevations, Boston City Base.
Details shown on these contract drawings are indicative of the type of structures wanted and are subject to revision by working drawings to be furnished from time to time.
For plan and sections of foundation embankments see Sheets 6, 7, 8 and 9.
For profile of dike see Sheet 4.
For grading plan of dike see Sheet 10.
For details of roadway on top of dike see Sheet 12.

COMMONWEALTH OF MASSACHUSETTS
METR. DIST. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
DIKE EMBANKMENT
TYPICAL CROSS SECTIONS

OCTOBER 1, 1934

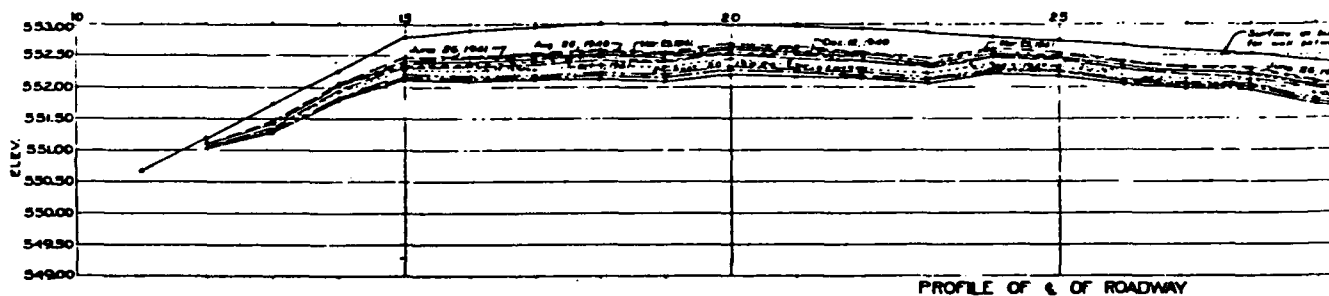
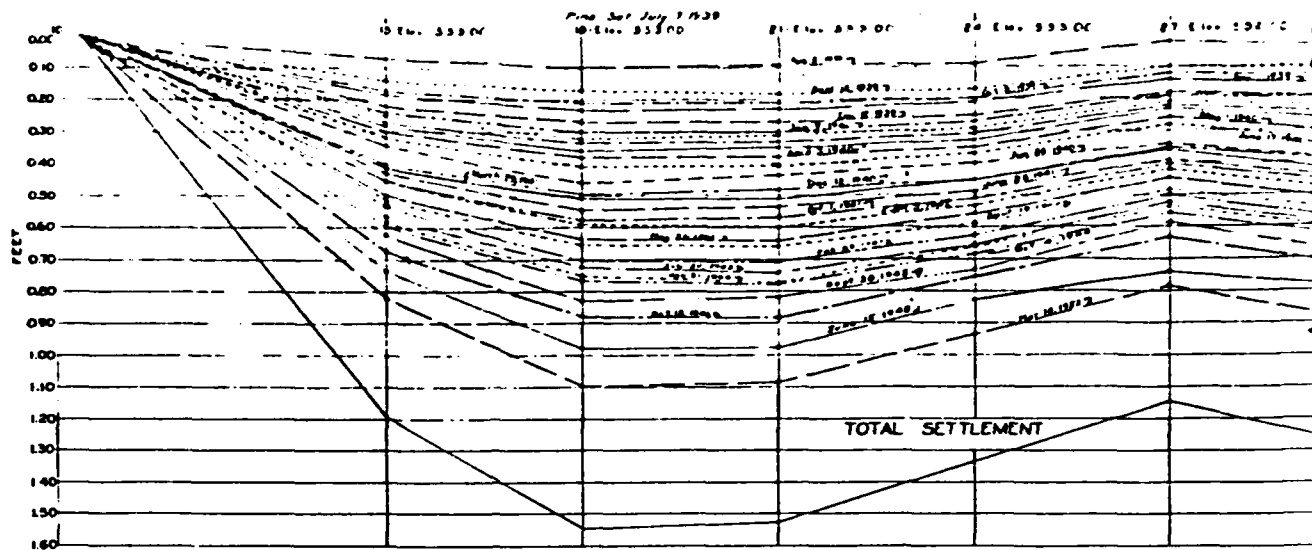
Charles D. Klein
Consulting Engineers

File Cont. 50-2325

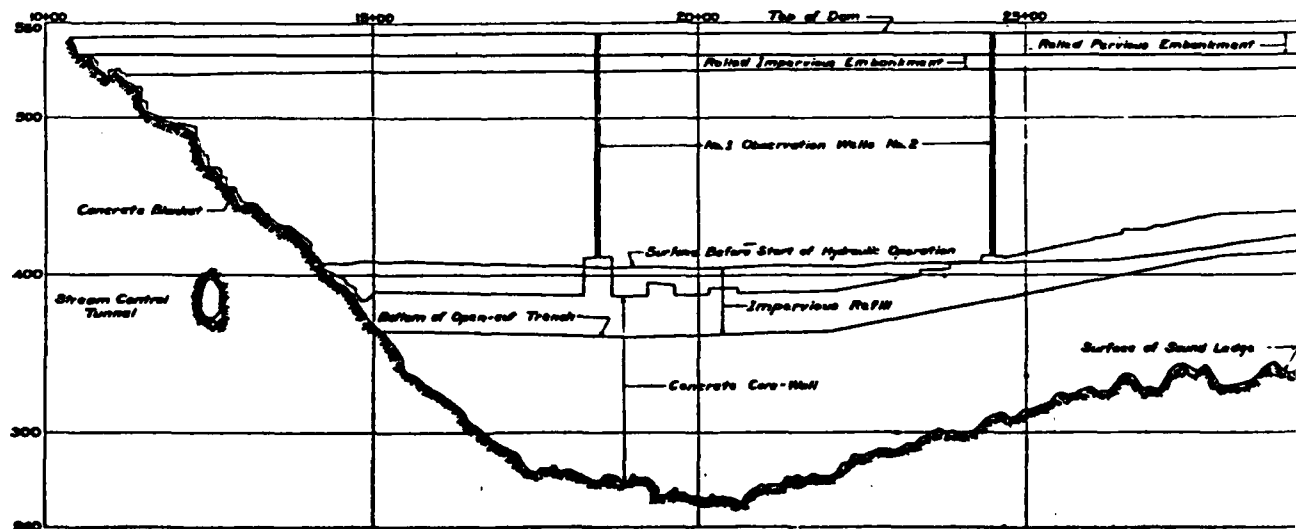
Acc. 2040

APPENDIX B-68

2

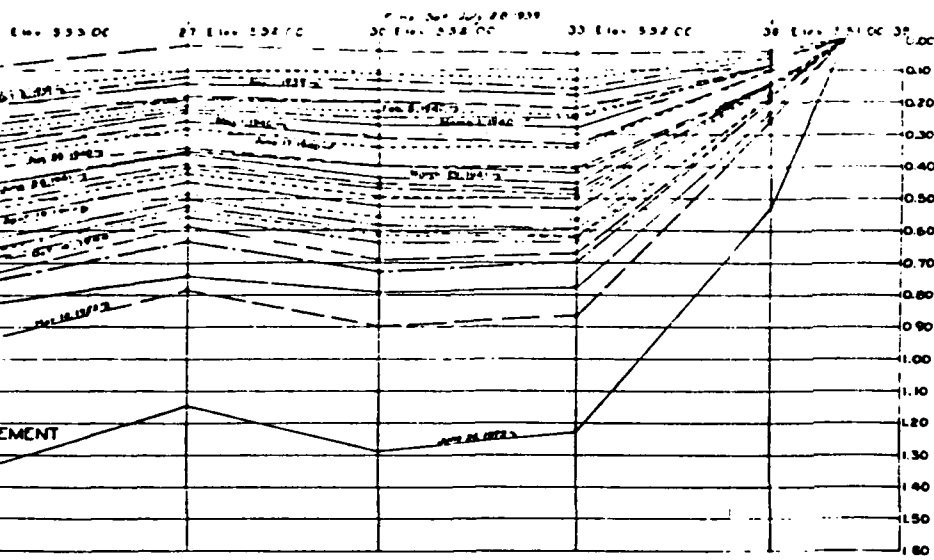


PROFILE OF & OF ROADWAY

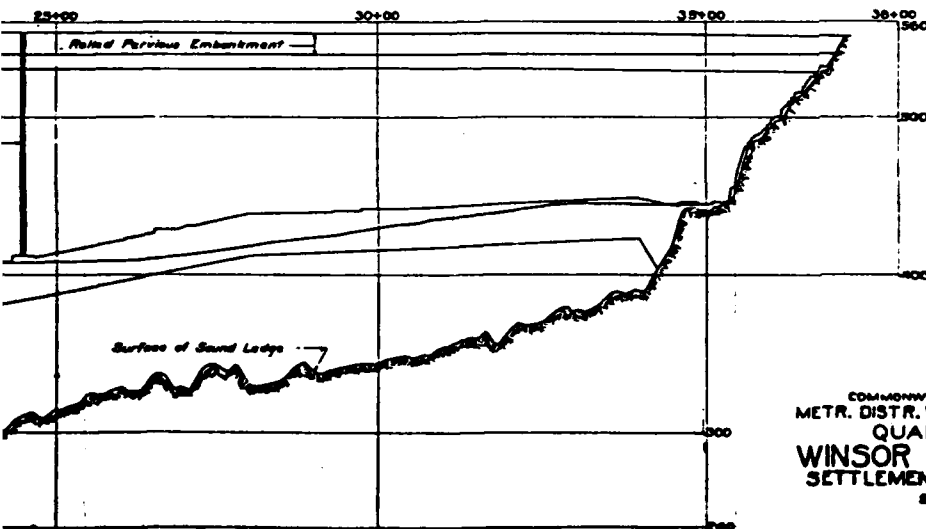
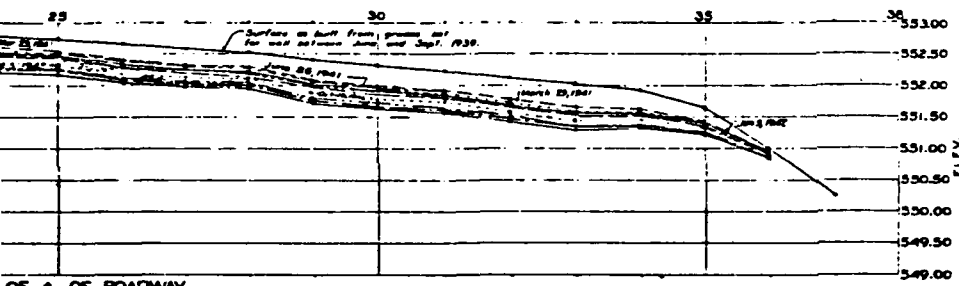


PROFILE ON CENTER LINE OF DAM LOOKING UPSTREAM

①

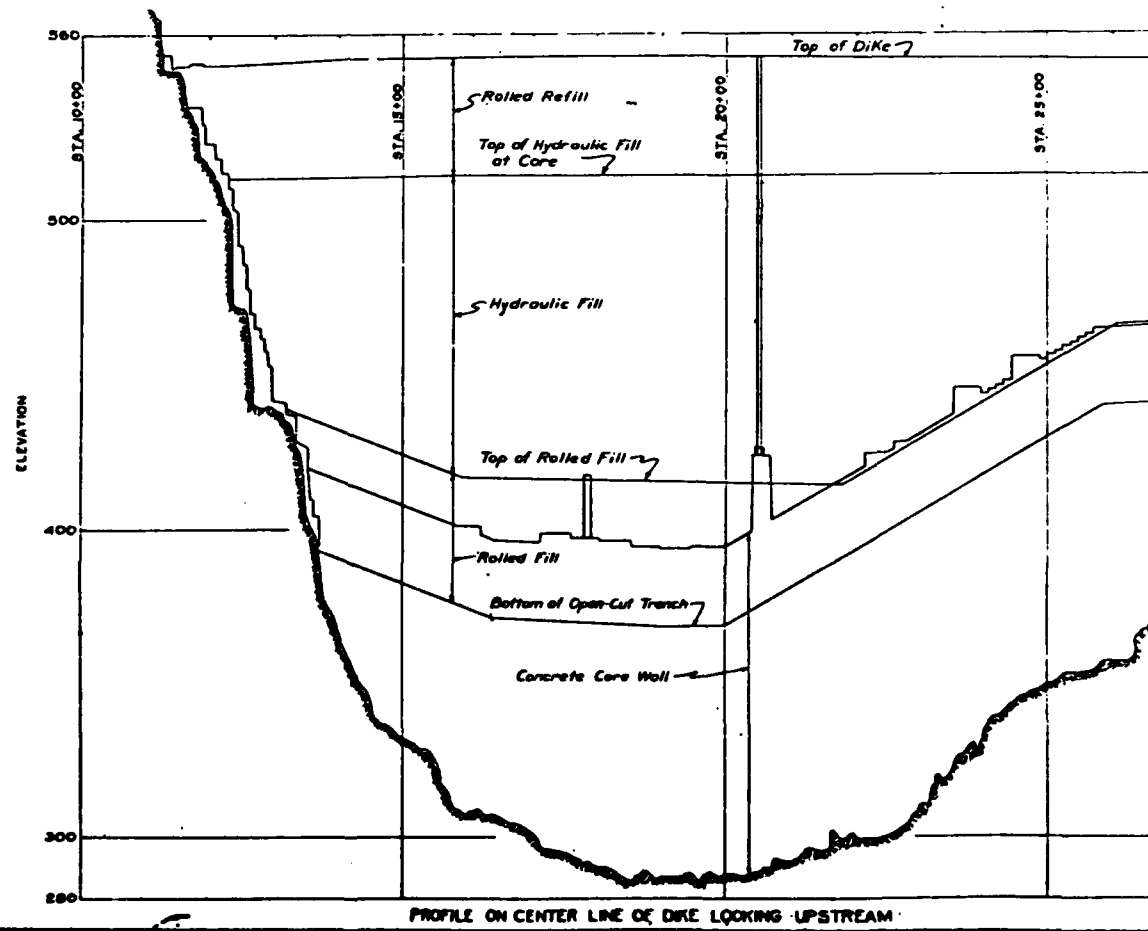
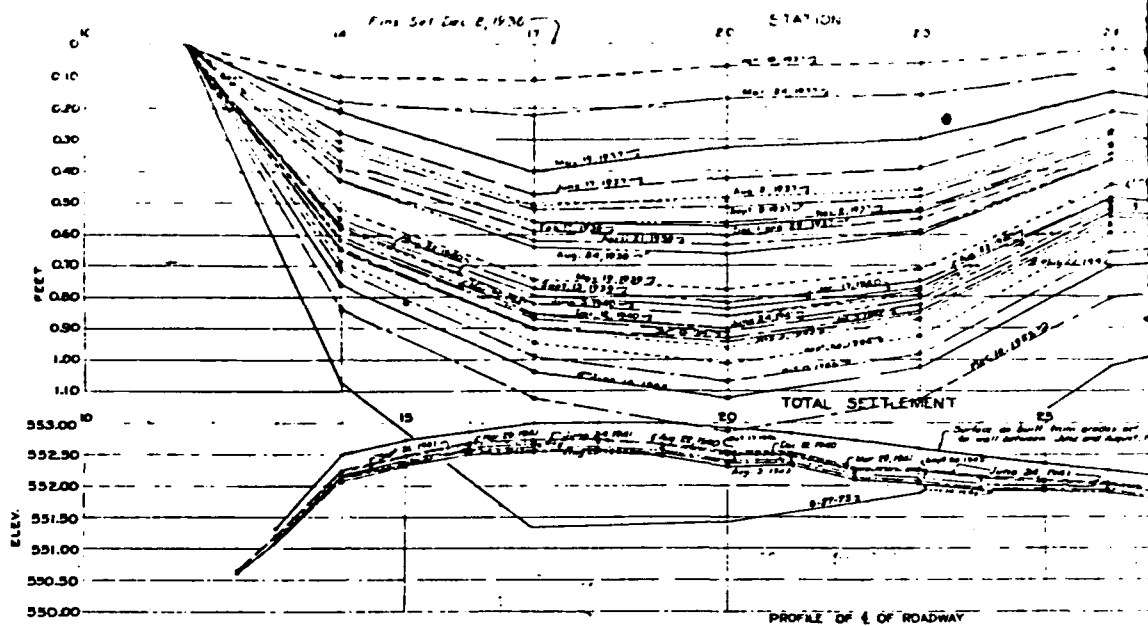


LOCATION OF SETTLEMENT PNE	
STATION	OFFSET
15+00	17.0' L
18+00	18.5' -
21+00	18.5' -
24+00	18.4' -
27+00	18.5' -
30+00	19.6' -
33+00	18.6' -
36+00	18.6' -



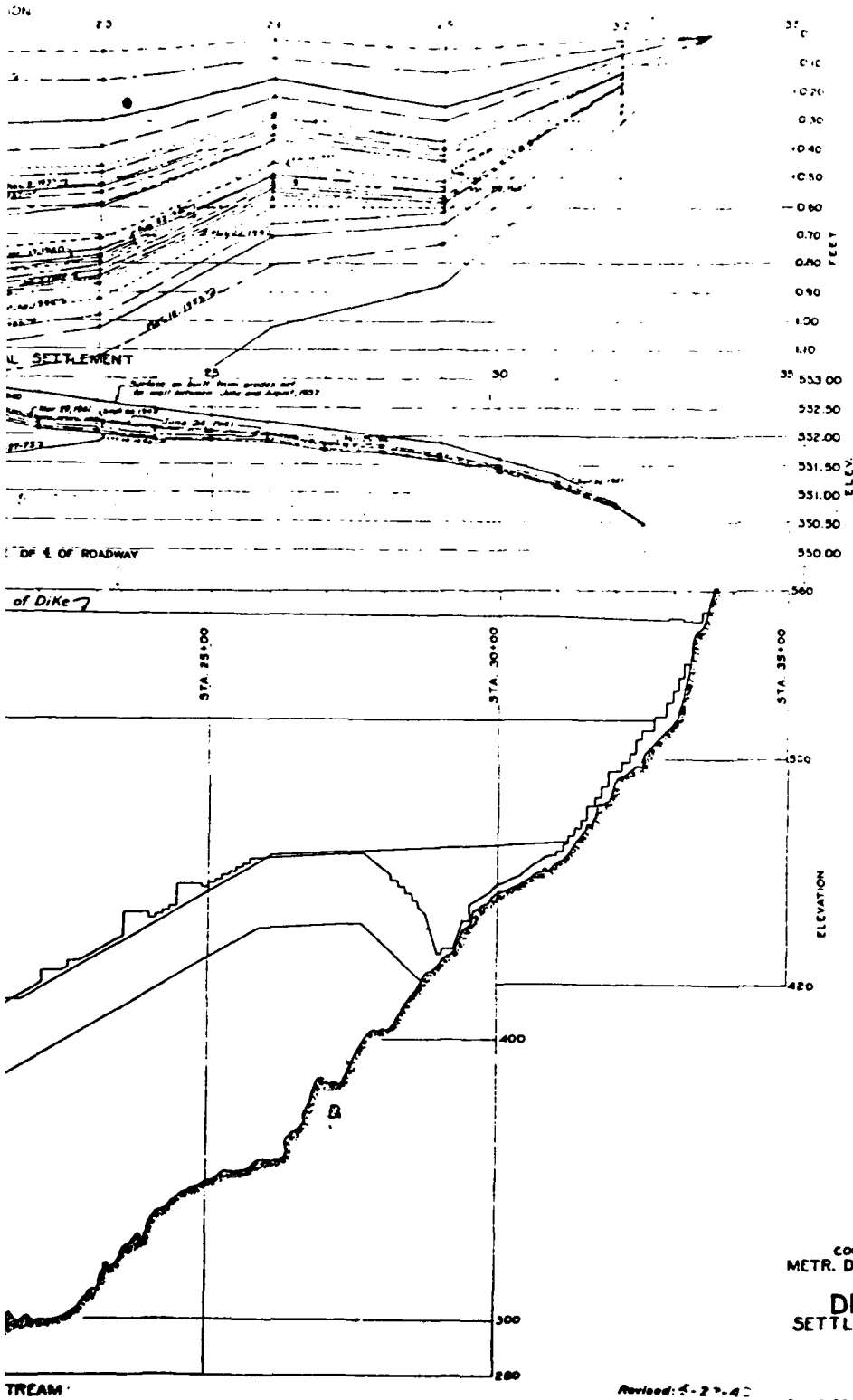
COMMONWEALTH OF MASSACHUSETTS
METR. DIST. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
WINSOR DAM EMBANKMENT
SETTLEMENT OF THE EMBANKMENT
SCALES AS SHOWN
OCTOBER 20, 1940

2



File 4160 B31

RETRACTED FROM ALL NOTES



COMMONWEALTH OF MASSACHUSETTS
METR. DISTR. WATER SUPPLY COMMISSION
QUABBIN RESERVOIR
DIKE EMBANKMENT
SETTLEMENT OF THE EMBANKMENT
SCALES AS SHOWN
OCTOBER 10, 1939

Revised: 5-27-42

Fig. 2.32.8

Acc. 17641

APPENDIX B-70

2

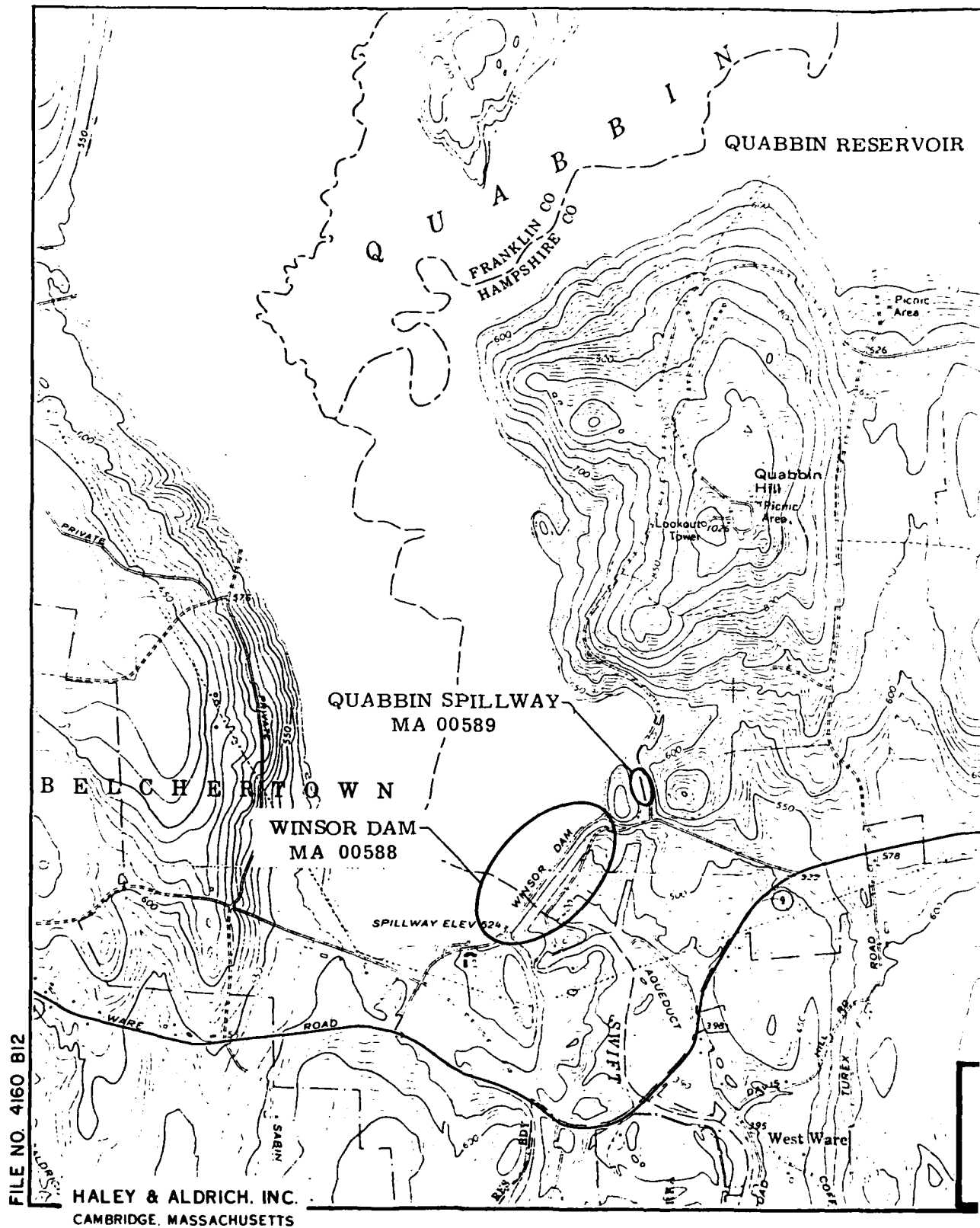
APPENDIX C
SELECTED PHOTOGRAPHS OF PROJECT

<u>LOCATION PLANS</u>	<u>Page No.</u>
Winsor Dam and Quabbin Spillway	1
Quabbin Spillway	2
Goodnough Dike	3

<u>PHOTOGRAPHS</u>				<u>Page No.</u>
<u>No.</u>	<u>Title</u>	<u>Roll</u>	<u>Frame</u>	
1.	Winsor Dam Monument, Located at Right Abutment	12	4	4
2.	Downstream Slope, From Left Abutment	12	10	vi, 4
3.	Roadway Crest and Downstream Slope, From Right Abutment	12	9	5
4.	Upstream Slope Near Left Abutment	12	11	5
5.	Upstream Slope From Roof of Intake Structure	12	15	6
6.	Entrance to Intake Structure, at Crest of Dam	12	8	6
7.	Stone Masonry Walls at Roof Level, Intake Structure	12	6	7
8.	Stone Masonry Wall Left of Intake Structure	12	7	7
9.	Intake Structure	12	16	8
10.	Gate and Screens Inside Intake Structure	12	17	8
11.	Auxiliary Spillway and Approach Channel, Looking Toward Quabbin Reservoir	12	21	9
12.	Crest of Auxiliary Spillway	12	20	9
13.	Quabbin Spillway, Overall View	11	0A	vi, 10
14.	Quabbin Spillway Weir	12	3	10
15.	Spillway Weir and Bedrock, Water Flowing From Drill Holes	13	13	11
16.	Spillway Weir at its Highest Point	13	6	11
17.	Spillway Weir Showing Vertical Crack in Granite Masonry	13	9	12
18.	Closeup of Vertical Crack	13	8	12
19.	Side Spillway with Stoplogs	13	23	13
20.	Side Spillway and Walkway	12	2	13
21.	Approach Channel to Spillway	13	25	14

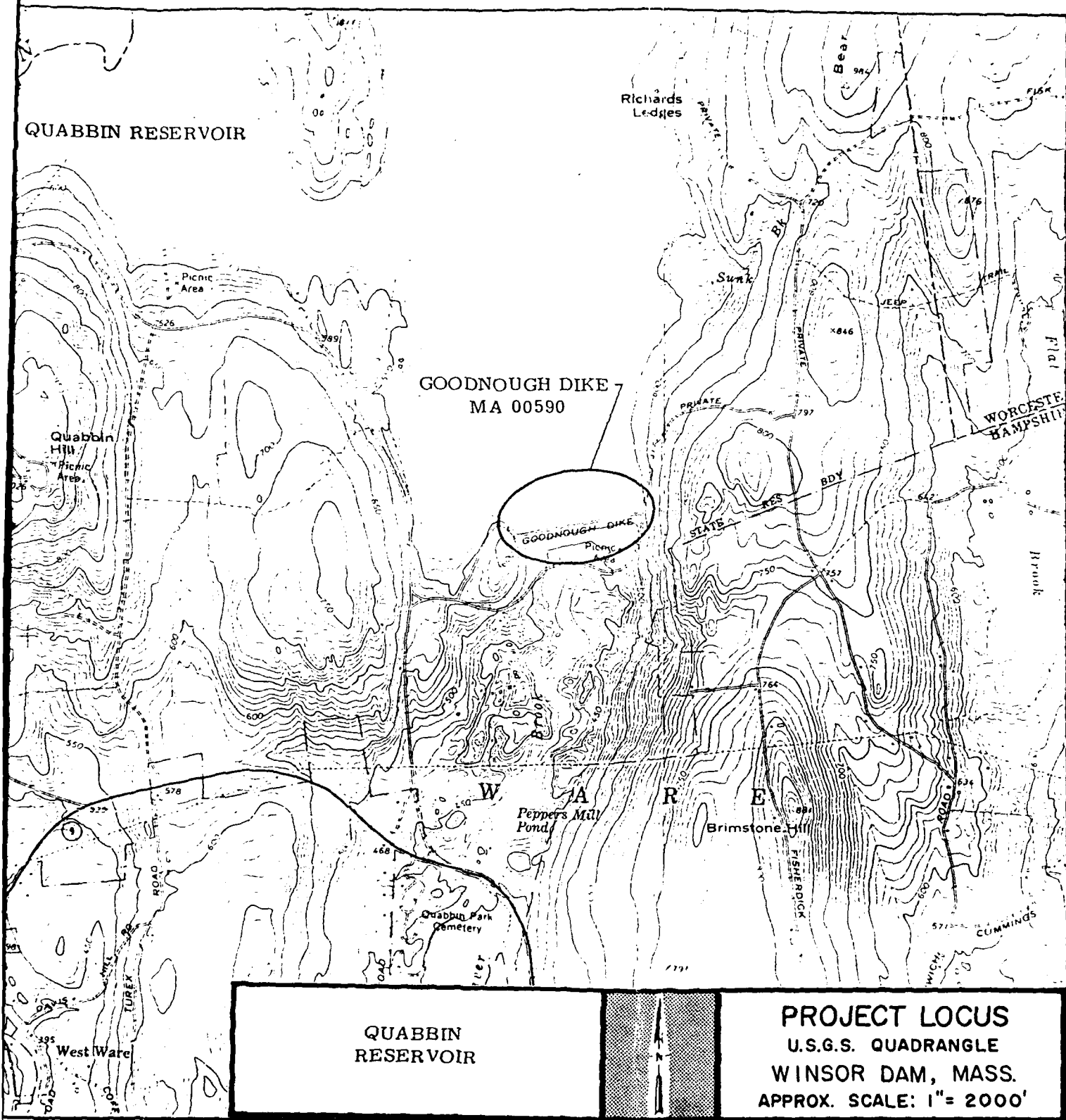
PHOTOGRAPHS (Continued)

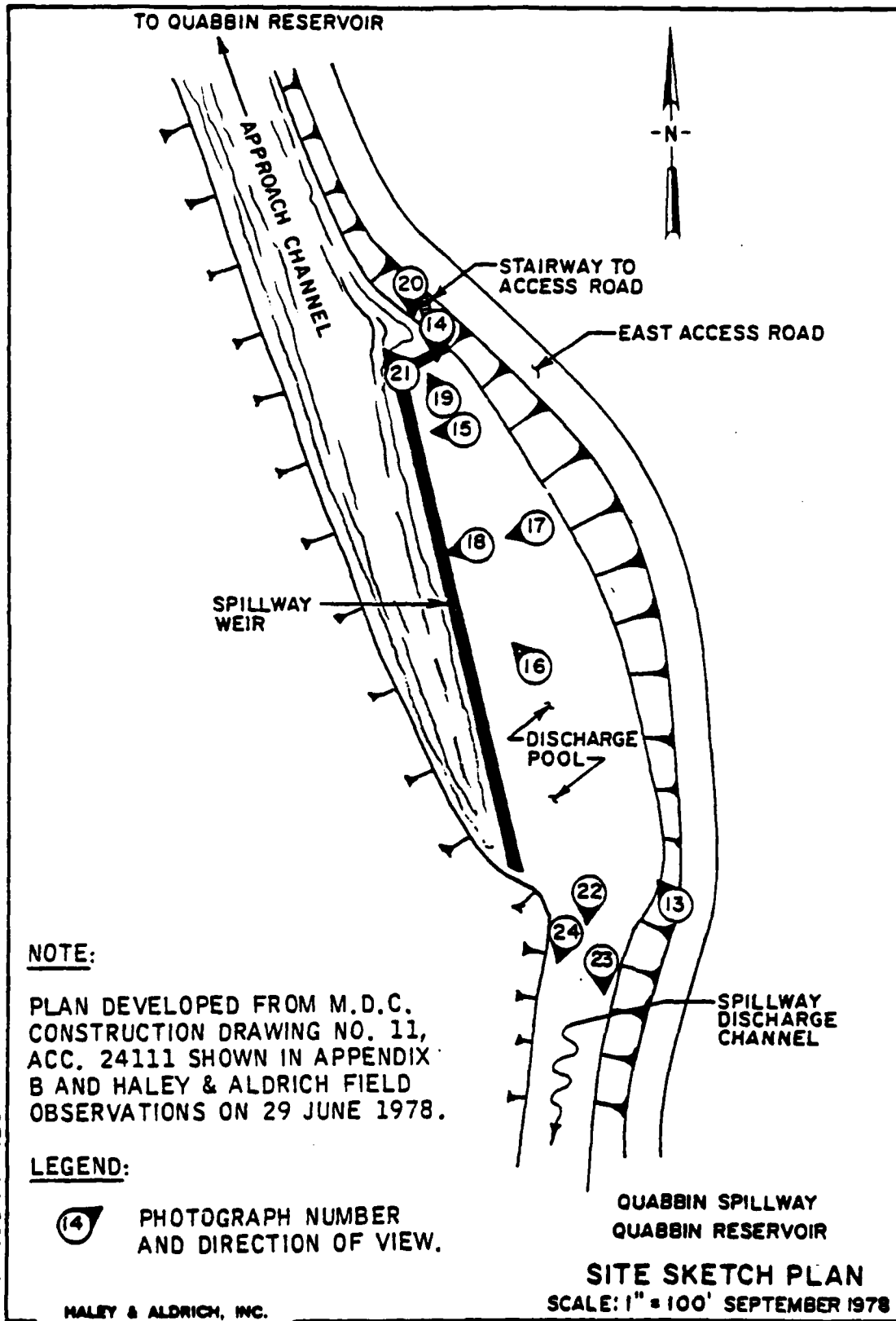
<u>No.</u>	<u>Title</u>	<u>Roll</u>	<u>Frame</u>	<u>Page No.</u>
22.	Discharge Channel From Spillway	13	4	14
23.	Rock Cut at Entrance to Spillway	13	20	15
	Discharge Channel, Left Side			
24.	Rock Cut at Entrance to Spillway	13	14	15
	Discharge Channel, Right Side			
25.	Spillway Discharge Channel Below Highway Bridge	12	25	16
26.	Goodnough Dike Monument	11	1A	16
27.	Roadway Across Embankment	11	2A	17
28.	Downstream Slope From Right Abutment	11	3A	17
29.	Downstream Slope From Near Toe of Dike	11	7A	vii, 18
30.	Unmowed Wet Areas Near Downstream Toe	11	10A	18
31.	Seepage Through Paved Ditch, Downstream of Wet Areas	11	8A	19
32.	Upstream Slope	11	15A	19
33.	Settlement Observation Pipe on Upstream Slope Near Crest of Dike	11	11A	20



FILE NO. 4160 B12

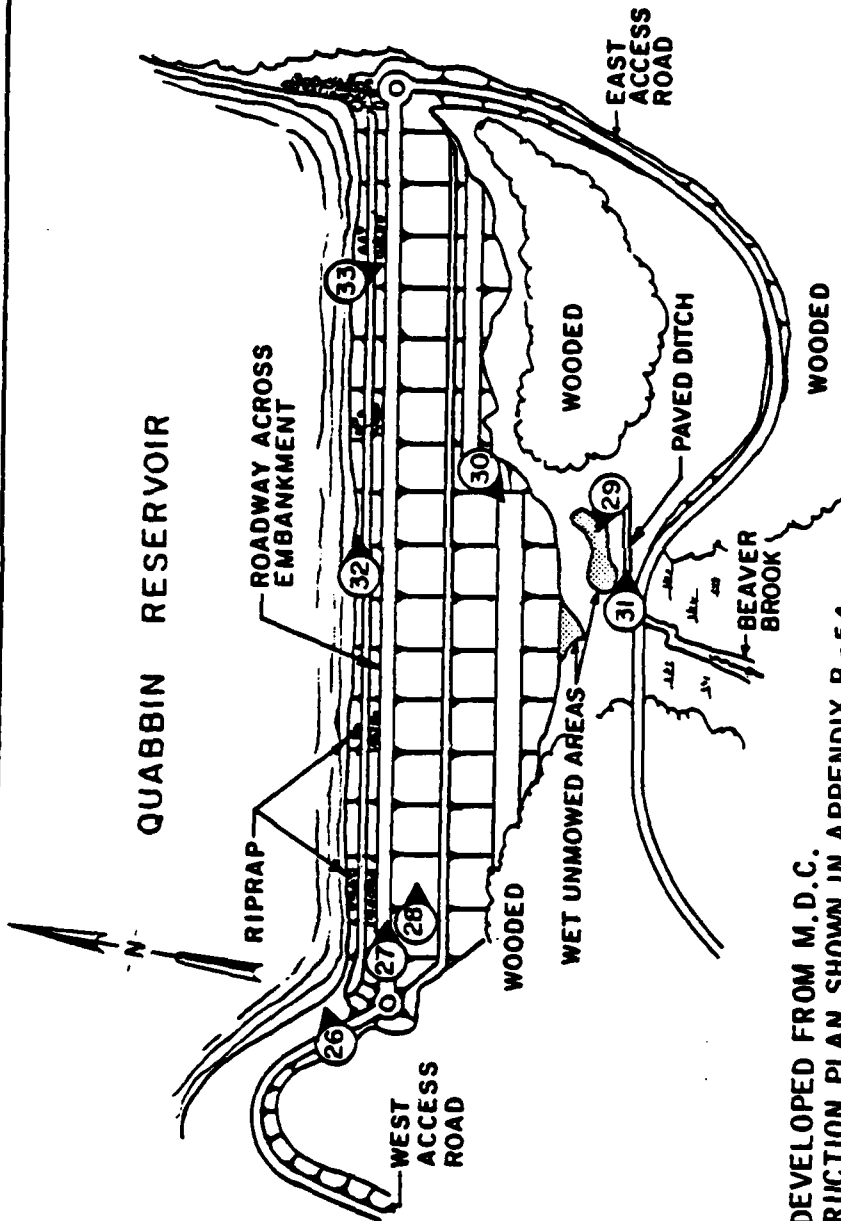
HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS





FILE NO 4160 00 A30

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS



NOTE:

PLAN DEVELOPED FROM M.D.C.
CONSTRUCTION PLAN SHOWN IN APPENDIX B-54
AND HALEY & ALDRICH, INC. FIELD
OBSERVATIONS ON 29 JUNE 1978.

LEGEND:

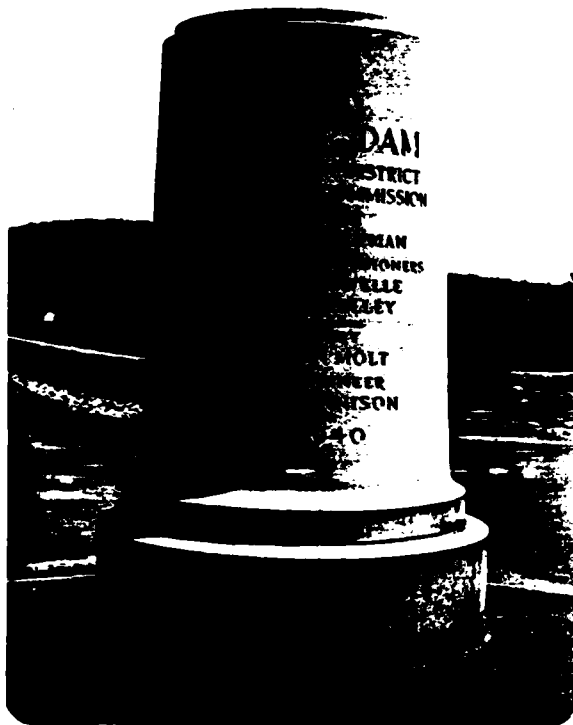


PHOTOGRAPH NUMBER AND
DIRECTION OF VIEW.

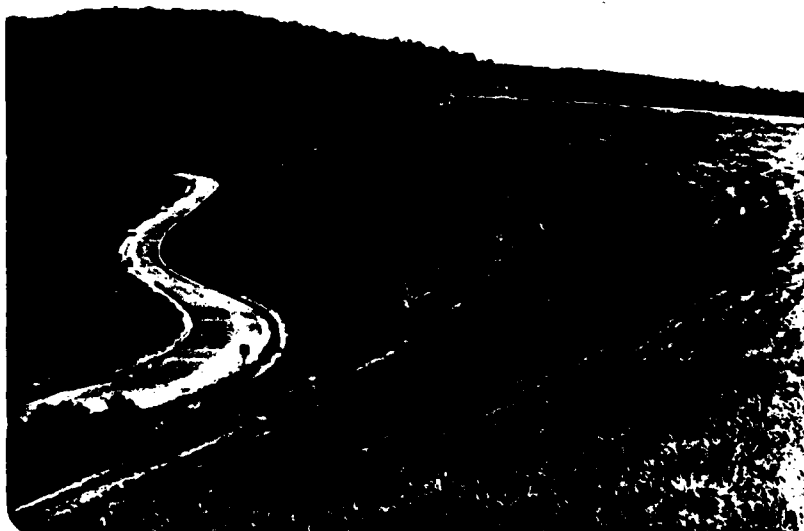
GOODNOUGH DIKE
QUABBIN RESERVOIR

SITE SKETCH PLAN

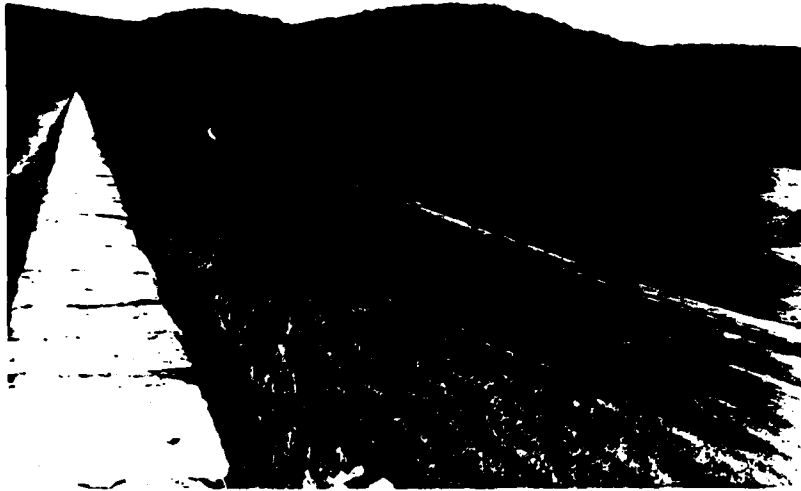
SCALE: 1" = 400' SEPTEMBER 1978



1. Winsor Dam Monument, Located at Right Abutment



2. Downstream Slope, From Left Abutment



3. Roadway Crest and Downstream Slope, From Right Abutment



4. Upstream Slope Near Left Abutment



5. Upstream Slope From Roof of Intake Structure



6. Entrance to Intake Structure, at Crest of Dam



7. Stone Masonry Walls at Roof Level, Intake Structure



8. Stone Masonry Wall Left of Intake Structure



9. Intake Structure



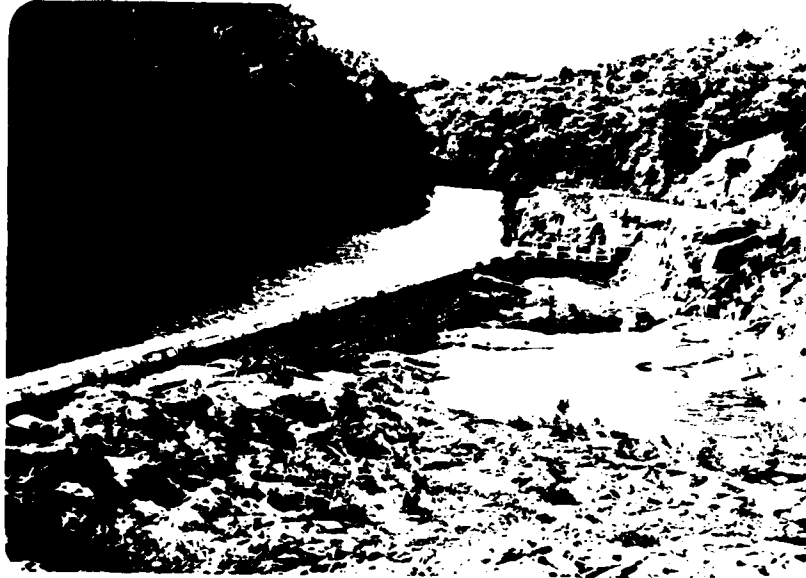
10. Gate and Screens
Inside Intake
Structure



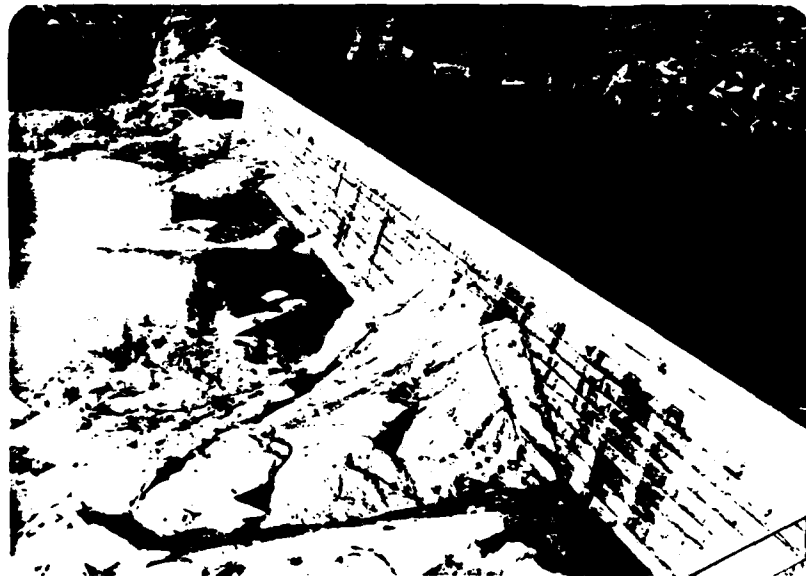
11. Auxiliary Spillway and Approach Channel, Looking
Toward Quabbin Reservoir



12. Crest of Auxiliary
Spillway



13. Quabbin Spillway, Overall View



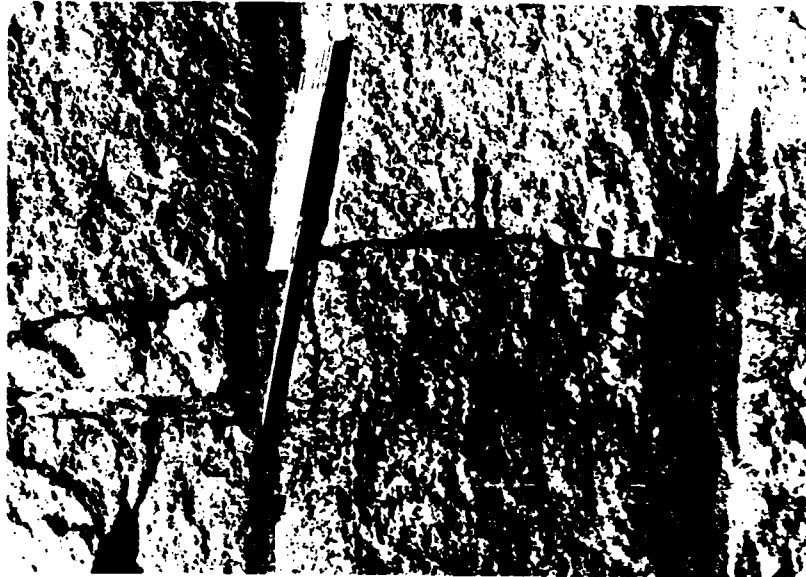
14. Quabbin Spillway Weir



15. Spillway Weir and Bedrock, Water Flowing From Drill Holes



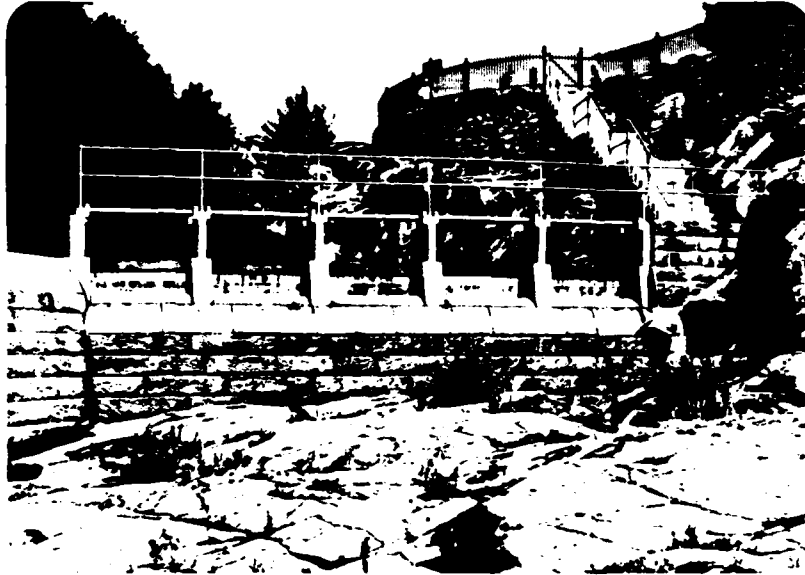
16. Spillway Weir at its Highest Point



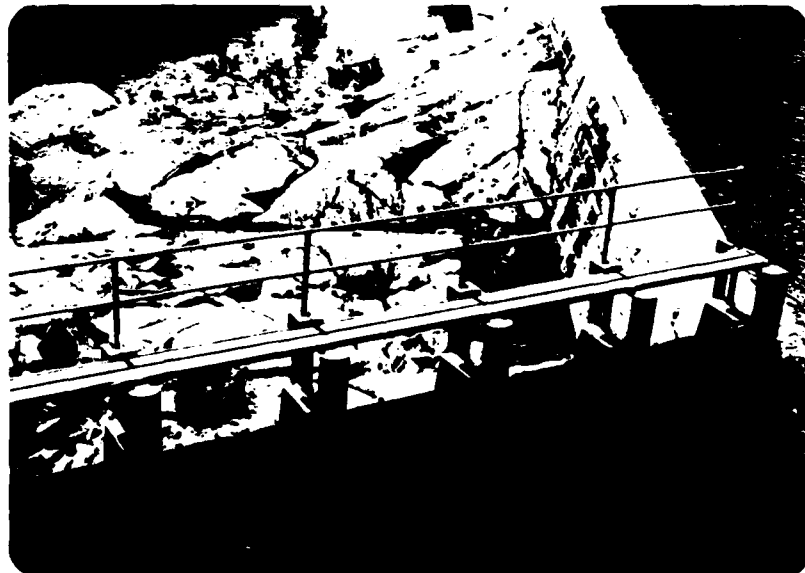
18. Closeup of Vertical Crack



17. Spillway Weir Showing Vertical
Crack in Granite Masonry



19. Side Spillway with Stoplogs



20. Side Spillway and Walkway



21. Approach Channel to Spillway



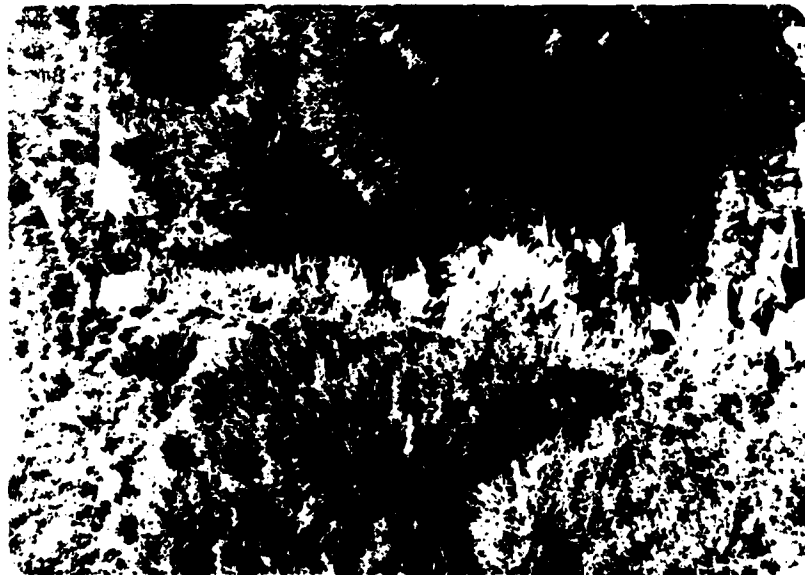
22. Discharge Channel From Spillway



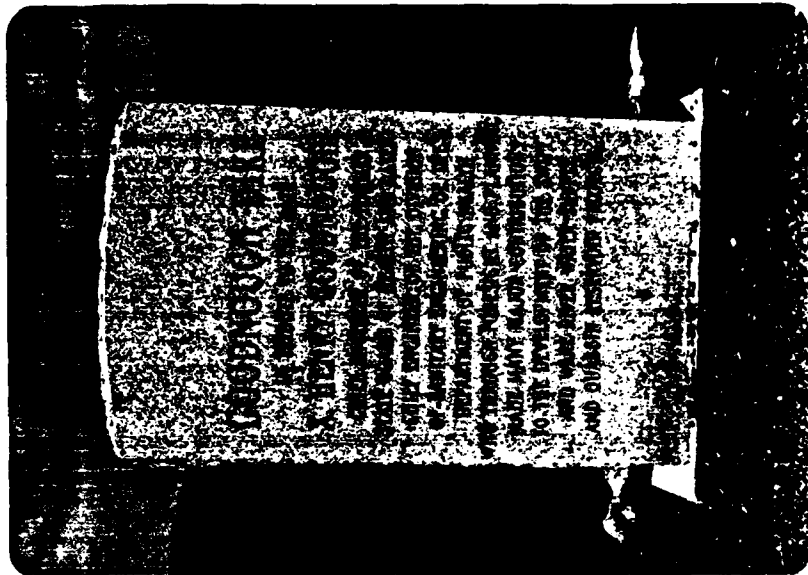
23. Rock Cut at Entrance to Spillway Discharge Channel,
Left Side



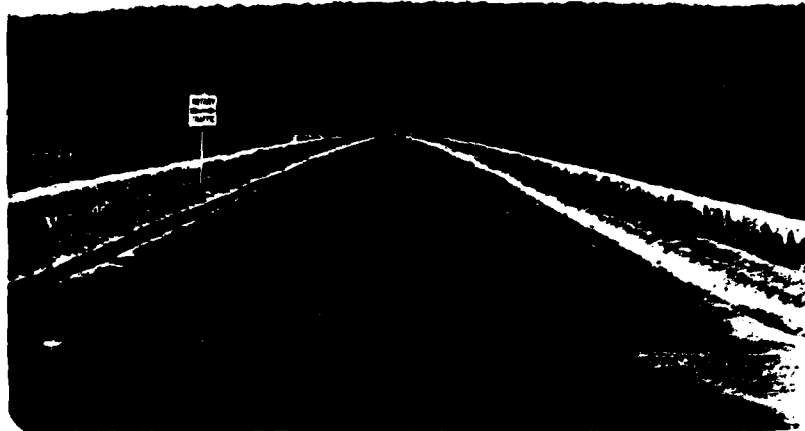
24. Rock Cut at Entrance to Spillway Discharge Channel,
Right Side



25. Spillway Discharge Channel Below
Highway Bridge



26. Goodnough Dike Monument



27. Roadway Across Embankment



28. Downstream Slope From Right Abutment



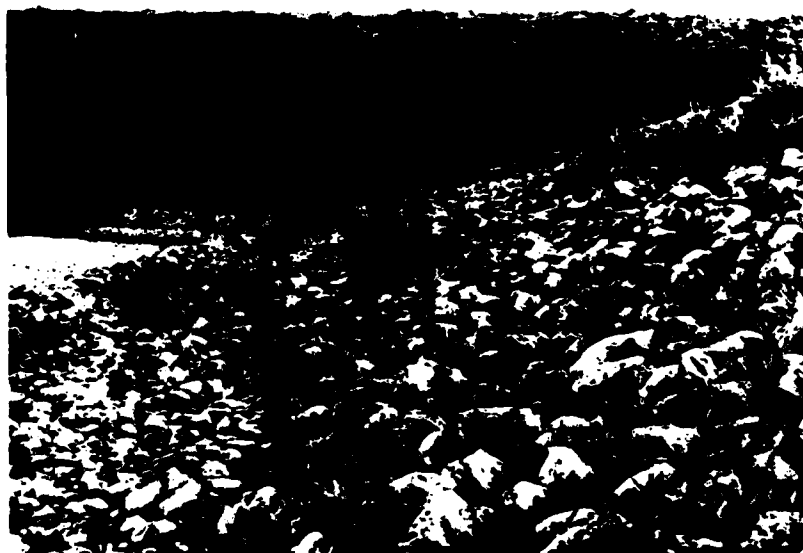
29. Downstream Slope From Near Toe of Dike



30. Unmowed Wet Areas Near Downstream Toe



31. Seepage, Through
Paved Ditch, Down-
Stream of Wet Areas



32. Upstream Slope



33. Settlement Observation Pipe on
Upstream Slope Near Crest of Dike

APPENDIX D
OUTLINE OF DRAINAGE AREA AND
HYDRAULIC COMPUTATIONS

OUTLINE OF DRAINAGE AREA

Page No.

Drainage Area Map

1

COMPUTATIONS

Size Classification, Hazard Potential Classifica-
tion, Test Flood, Drainage Area,

Maximum Probable Flood, Historical Data

2

Development of Unit Hydrograph for East Branch
Swift River

3

Development of Unit Inflow Hydrograph for Quabbin
Reservoir - Land Portion

5

Routing of Inflow PMF

7

Dam Failure Analysis

26

Field Notes

27



CAMP DRESSER & McKEE Inc.
Consulting Engineers
Boston, Mass.



**QUABBIN RESERVOIR
DRAINAGE AREA**

SCALE 1:250 000

APPENDIX D-1

CAMP DRESSER & MCKEE
Environmental Engineers
Boston, Mass.

CLIENT HALEY & ALDRICH
PROJECT WAT' & DAM IMP. GR. I.
DETAIL QUABBIN SPILLWAY

JOB NO. 561-B-87
DATE CHECKED 9/25/78
CHECKED BY dlb

PAGE A1
DATE 7-19-78
COMPUTED BY VED

SIZE CLASSIFICATION:

Height = 155'
Storage = 412 billion gals. } LARGE

HAZED POTENTIAL CLASSIFICATION:

Estimated loss of life is 2-300 persons

Category is HIGH

TEST FLOOD:

HIGH HAZARD & LARGE Size → Test flood = PMF

DRAINAGE AREA: 186 sq. mi. + diversion from Ware River

MAXIMUM PROBABLE FLOOD: (see attached pages B3 thru C13)

PMF INFLOW = 226,800 cfs

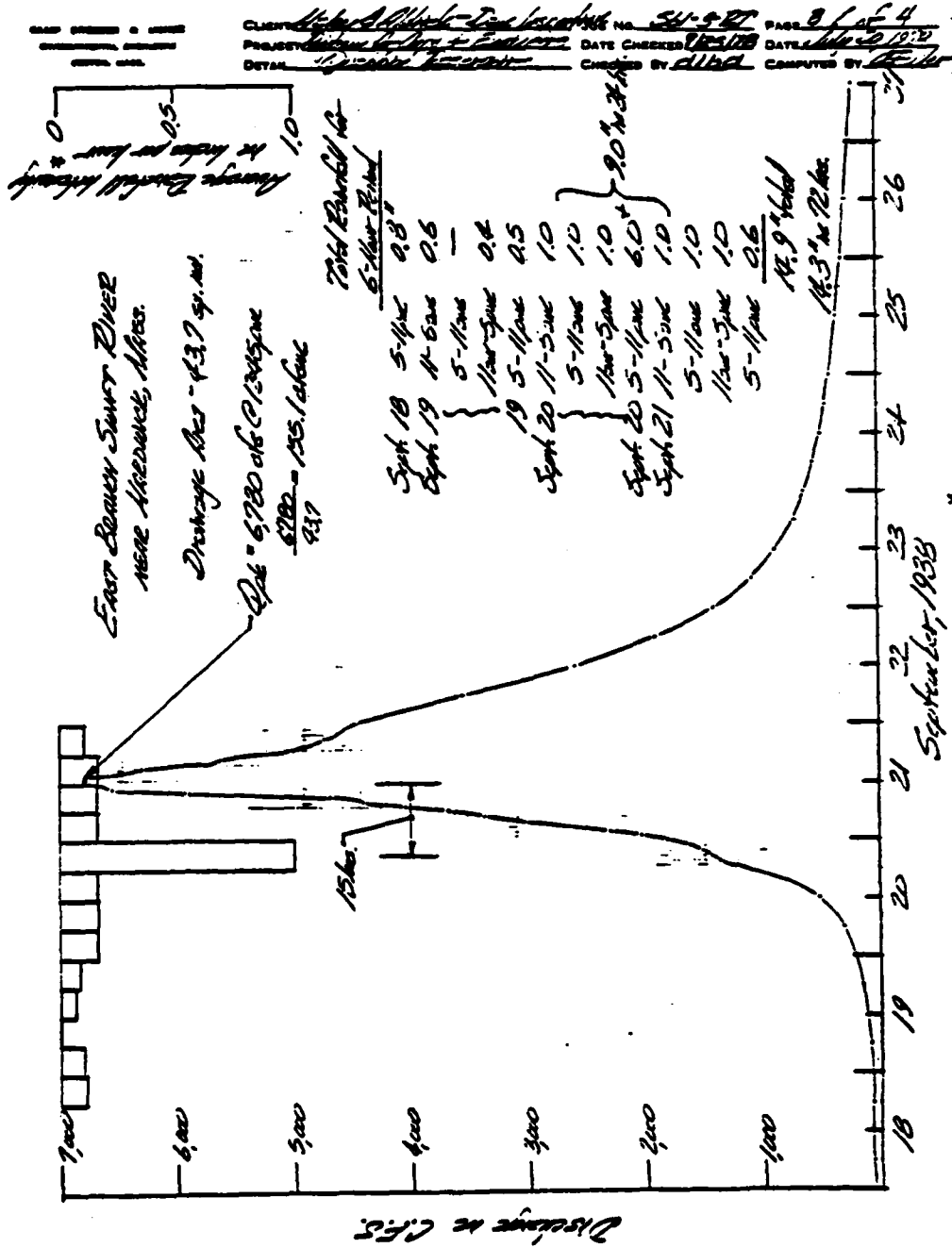
PMF OUTFLOW = 16,300 cfs

HISTORICAL DATA:

Maximum Recorded Spillway Discharge:

1,927 cfs on April 18, 1953

see field notes for other recorded discharge info.



CAMP DRESSER & JARVIS
Environmental Engineers
Boston, Mass.

CLIENT: U.S. Navy - Naval Air Station JOB NO. 54-9-27
PROJECT: Study of the Air Station DATE CHECKED: 11/25/78
DETAIL: Physical Environment CHECKED BY: dlb

PAGE 2 of 4
DATE: 11/25/78
COMPUTED BY: dlb

For the purpose of this study, the following data was used:

Duration of Data Collection - June 4 - September 1952

Date Size (in ft) Area (sq ft) Volume (cu ft) Weight (lb)

Sept 13	63 x 63	20 x 20	49 x 49	5.57 x 10 ⁶
19	120	30	90	10.00
20	720	30	800	72.9
21	4680	4	1680	539.5
22	2750	40	2590	312.3
23	927	70	257	99.5
24	503	30	123	49.1
25	350	20	310	30.2
26	267	100	167	10.3
27	220	110	110	12.8
28	235	120	85	9.16
29	186	130	56	6.50
30	159	140	19	2.21

Σ = 10,125 cu ft

Volume of Results = 10,125 cu ft (40/60/20) = 272, 200, 222 ft³

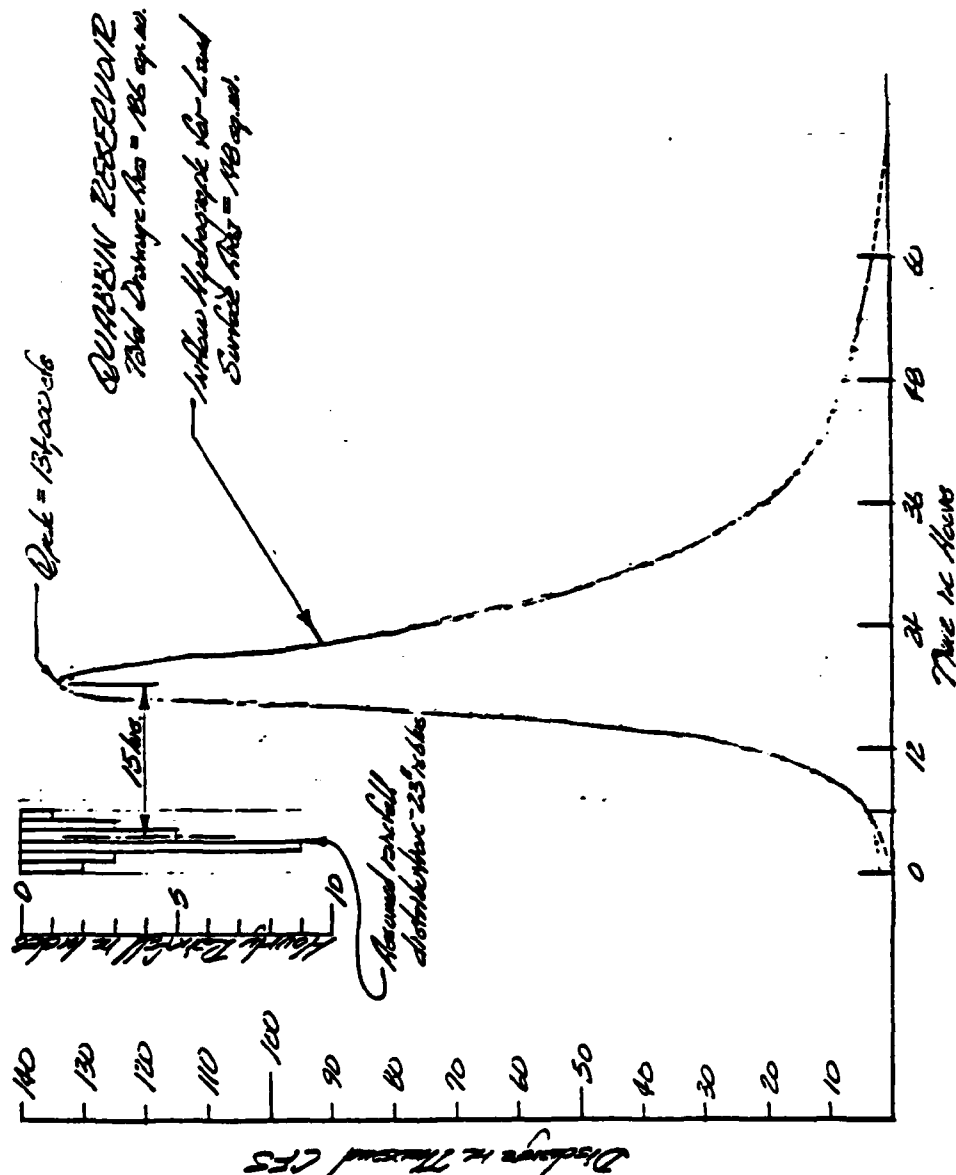
Result = $\frac{574,900,000 \text{ ft}^3}{(0.272 \text{ ft}^3) (1.2 \text{ ft}^3)} = 0.71805 = 262 \text{ M}$

The Experiment, 1952, shows that the following were the frequencies:

<u>Total</u>	<u>in Time</u>	<u>Frequencies</u>
60	6 hr	> 1000 yr
90	36 hr	> 1000 yr
143	72 hr	> 1000 yr

DAVE BRIDGES & ASSOCIATES
ENGINEERING, ARCHITECTURE
CONSULTANTS

CLIENT Water Pollution Control Authority JOB NO. 54-377 PAGE B-3 of 4
PROJECT Chickadee Creek Wastewater Treatment Plant DATE CHECKED 9/15/88 DATE July 20/88
DETAIL Discharge Hydrograph CHECKED BY dlb COMPUTED BY dlb



PAGE 24 - 44
DATE 11-1-72
COMPUTED BY 11-1-72

APPENDIX D-6

CAMP CRENSHAW & MARLEY
Environmental Engineers
Boston, Mass.

CLIENT John J. Marley - 1000 - 1000
PROJECT 1000 - 1000 - 1000
DETAIL 1000 - 1000

JOB NO. 54-3-10
DATE CHECKED 9/25/78
CHECKED BY dlb

PAGE C-1-1
DATE 9/25/78
COMPUTED BY dlb

<u>Initial August 78</u>			
<u>Time</u>	<u>Surface</u>	<u>Water</u>	<u>Drift</u>
0	2,000	0	0
3	2,000	0	0
6	4,200	0	0
7	5,500	0	0
8	7,200	0	0
9	10,000	0	0
10	12,800	0	0
11	15,500	0	0
12	17,900	0	0
13	20,600	0	0
14	23,500	0	0
15	26,000	0	0
16	29,000	0	0
17	32,000	0	0
18	35,000	0	0
19	38,300	0	0
20	42,000	0	0
21	45,000	0	0
22	48,000	0	0
23	51,700	0	0
24	55,000	0	0
25	59,300	0	0
26	61,600	0	0
27	55,000	0	0
28	43,000	0	0
29	42,000	0	0
30	40,000	0	0
31	35,500	0	0
32	31,500	0	0
33	28,200	0	0
34	25,500	0	0
35	23,000	0	0
36	20,600	0	0
37	15,000	0	0
38	11,500	0	0
39	9,000	0	0
40	7,500	0	0
41	7,500	0	0
42	7,500	0	0
43	7,500	0	0
44	7,500	0	0
45	7,500	0	0
46	7,500	0	0
47	7,500	0	0
48	7,500	0	0
49	7,500	0	0
50	7,500	0	0
51	7,500	0	0
52	7,500	0	0
53	7,500	0	0
54	7,500	0	0
55	7,500	0	0
56	7,500	0	0
57	7,500	0	0
58	7,500	0	0
59	7,500	0	0
60	7,500	0	0
61	7,500	0	0
62	7,500	0	0
63	7,500	0	0
64	7,500	0	0
65	7,500	0	0
66	7,500	0	0
67	7,500	0	0
68	7,500	0	0
69	7,500	0	0
70	7,500	0	0
71	7,500	0	0
72	7,500	0	0
73	7,500	0	0
74	7,500	0	0
75	7,500	0	0
76	7,500	0	0
77	7,500	0	0
78	7,500	0	0
79	7,500	0	0
80	7,500	0	0
81	7,500	0	0
82	7,500	0	0
83	7,500	0	0
84	7,500	0	0
85	7,500	0	0
86	7,500	0	0
87	7,500	0	0
88	7,500	0	0
89	7,500	0	0
90	7,500	0	0
91	7,500	0	0
92	7,500	0	0
93	7,500	0	0
94	7,500	0	0
95	7,500	0	0
96	7,500	0	0
97	7,500	0	0
98	7,500	0	0
99	7,500	0	0
100	7,500	0	0

CAMP DRESSER & MCKEE
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Boston, Mass.

CLIENT U.S. Army Corps of Engineers JOB NO. 54-9-P
PROJECT Channel Maintenance DATE CHECKED 9/25/78
DETAIL Hydrology CHECKED BY dlb

PAGE 52-10
DATE 10/1/78
COMPUTED BY dlb

Spillway Channel Hydraulics

H = 1.0'
Reserve Q = 1516 cfs W.C. gullyway = 531.0

Channel depth = 531.0 - 514.0 = 17.0'

Channel area = 1063.4 sq ft Channel velocity = $\frac{1516 \text{ cfs}}{1063.4 \text{ sq ft}} = 1.42 \text{ fps}$

$V^2 = 0.031'$

$\therefore E.S. = 531.0 + 0.03 = 531.03'$

Reserve area at approach channel = 1.54 ft = 17

N = 26.2

Then, $K_s = \frac{1.25 \times 0.02}{1.496 (1.346)^{3/2}} \times 1.0 = 0.00455'$

$R = \frac{1063.4}{531.0} = 1.99$

Then E.S. P minor = 531.03 + 0.005 = 531.035 $C = \frac{1516}{1063.4 \times 1.99} = 3.553$

$C = 3.553 / 1.99$

$C = 3.713 / 1.99$

H = 1.5'
Reserve Q = 2070 cfs W.C. gullyway = 531.5

Channel depth = 531.5 - 514.0 = 17.5'

Channel area = 1101.2 sq ft Channel velocity = $\frac{2070 \text{ cfs}}{1101.2 \text{ sq ft}} = 1.88 \text{ fps}$

$V^2 = 0.105'$

$\therefore E.S. = 531.5 + 0.105 = 531.605'$

Reserve area at approach channel = 2.45 ft = 17

N = 26.2

Then, $K_s = \frac{2.15 \times 0.02}{1.496 (1.52)^{3/2}} \times 1.0 = 0.0174'$

$R = \frac{1101.2}{531.5} = 2.07$

Then E.S. P minor = 531.605 + 0.017 = 531.622

$C = \frac{2070}{1101.2 \times 2.07} = 3.733$

$C = 3.733 / 2.07$

$C = 3.774 / 2.07$

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CLIENT Abigail Electric Light & Power Corp. JOB NO. 51-4-20
PROJECT Abigail Electric Light & Power Corp. DATE CHECKED 9/25/78
DETAIL Hydrology CHECKED BY dib

PAGE 5 of 5
DATE 9/25/78
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$$N = 20'$$

$$Return D = 440.0 \text{ cfs} \quad WSC \text{ frequency} = 532.0$$

$$\text{Channel depth} = 532.0 - 512.0 = 20.0'$$

$$\text{Channel area} = 1131.2' \therefore \text{Channel velocity} = \frac{440.0 \text{ cfs}}{1131.2' \cdot 2} = 0.194 \text{ ft/sec}$$

$$\frac{V^2}{2g} = 0.035'$$

$$\therefore E_{\text{eff}} = 52.0 + 0.035 = 52.035'$$

$$\text{Return rate with appropriate channel} = 3.9 \text{ ft} = 7'$$

$$N = 0.02$$

$$\text{Then, } K_c = \frac{3.9 + 0.02}{1.48 \sqrt{0.02}} \cdot \frac{7^2}{490} = 0.0397'$$

$$R = \frac{1131.2}{60 + 248} = 11.312$$

$$\text{Then } E_{\text{eff}} \text{ correction} = 52.035 + 0.039 = 52.074'$$

$$C = \frac{410}{104.572 \cdot 2} = 1.95$$

$$C = 3.179 \text{ (corr.)}$$

$$C = 3.782 \text{ (corr.)}$$

$$N = 25'$$

$$\text{Return D} = 6010.0 \text{ cfs} \quad WSC \text{ frequency} = 532.5$$

$$\text{Channel depth} = 532.5 - 512.0 = 20.5'$$

$$\text{Channel area} = 1167.2' \therefore \text{Channel velocity} = \frac{6010.0 \text{ cfs}}{1167.2' \cdot 2} = 2.582 \text{ ft/sec}$$

$$\frac{V^2}{2g} = 0.162'$$

$$\therefore E_{\text{eff}} = 52.5 + 0.162 = 52.662'$$

$$\text{Return rate with appropriate channel} = 2.9 \text{ ft} = 7'$$

$$N = 0.02$$

$$\text{Then, } K_c = \frac{2.9 + 0.02}{1.48 \sqrt{0.02}} \cdot \frac{7^2}{490} = 0.066'$$

$$R = \frac{1167.2}{50 + 248} = 12.053$$

$$\text{Then } E_{\text{eff}} \text{ correction} = 52.662 + 0.066 = 52.728'$$

$$C = \frac{6010}{104.572 \cdot 2} = 2.870$$

$$C = 2.870 \text{ (corr.)}$$

$$C = 2.870 \text{ (corr.)}$$

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Boston, Mass.

CLIENT U.S. Army Corps of Engineers JOB NO. 541-0-27
PROJECT Channel Maintenance - 0250010 - 0250011 DATE CHECKED 7/25/78
DETAIL Channel Maintenance CHECKED BY dlb

PAGE C-10
DATE 7/25/78
COMPUTED BY dlb

$$N = 3.0$$
$$Rough Q = 7525 \text{ cfs} \quad \text{W.S. of existing} = 532.0$$

$$\text{Channel depth} = 533.0 - 514.0 = 19.0'$$

$$\text{Channel area} = 1700 \text{ ft}^2 \quad \therefore \text{Channel velocity} = \frac{7525 \text{ cfs}}{1700 \text{ ft}^2} = 4.43 \text{ fps}$$

$$\frac{V}{2} = 0.610'$$

$$\therefore E.S. = 533.0 + 0.41 = 533.41'$$

$$\text{Assume 20% cut in roughness coefficient} = 53 \text{ fps} = V$$

$$\text{Then, } k_c = \frac{53^2 \times 0.22}{1.49 \times (2218)^{1/3}} = 0.2934'$$

$$N = 0.02$$

$$D = \frac{1.49 \times V}{N} = 10.238$$

$$\text{Then E.S. 12 months} = 533.41 + 0.094 = 533.504$$

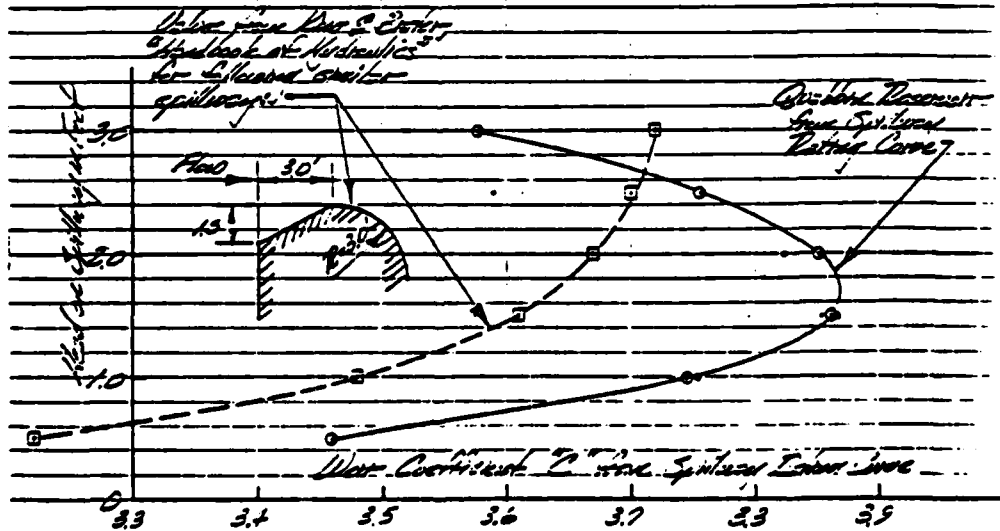
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Boston, Mass.

CLIENT United States Army JOB NO. 911-0-277
PROJECT Fort Belvoir, Missouri DATE CHECKED 9/25/78
DETAIL Hydrology CHECKED BY dlb

PAGE 65
DATE 9/25/78
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Spillway Protection
$$Q = 21.5 \sqrt{2(40.67)H^3}$$

W.S.	Distance	Spillway
51.4		
530.0	07.0	—
530.5	885	3.060
531.0	1516	2.716
531.5	2370	2.911
532.0	4610	3.853
532.5	6010	3.757
533.0	7825	3.579



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Boston, Mass.

CLIENT: U.S. Environmental Protection Agency JOB NO. 541-9-277
PROJECT: Spillway Design DATE CHECKED: 9/26/78
DETAIL: Spillway Design CHECKED BY: ELB

PAGE: 2
DATE: 9/26/78
COMPUTED BY: ELB

Spillway Design at Spillway Control Work

Because the C.C. is located on a downstream side of the Spillway Control Work, the spillway design curve between Elev. 530.0 and 535.0 is a maximum at H=12 ft. before decreasing to 3.579 at H=9.0, we must give the curve enough the benefit of the doubt and assume the curve is a maximum at H=9.0. Since the only curve given same H=9.0 is Q=15,000 cfs for H=6.0 (Elev. 535.0), we will adopt this and assume straight line between as follows:

<u>U.S. Discharge Schedule</u>		
<u>Elev.</u>	<u>Q (cfs)</u>	<u>H (ft)</u>
533.0	7,500	3.579
533.5	8,760	3.306
534.0	10,000	3.089
534.5	11,240	2.910
535.0	12,480	2.758
535.5	13,740	2.632
536.0	15,000	2.522
536.5	16,200	2.428
537.0	17,500	2.335

flow would require a larger rock cut, but the material quarried from this cut can be used for riprap on the upstream face of the dam. The discharge area of the reservoir is that of the watershed of the three branches of the Saco River, west, middle and east, and the three branches of all three are largely forest land and woodland. There is no one branch that is much steeper than the other two, which are steep only at the headwaters and which are much more gradual in the lower reaches of the main trunk. Most of the flood flow from the west branch yields at the site of the dam before the flow from the east and middle branches arrive. This condition gives a flood flow curve which has a flat peak of long duration. The maximum flood peak for the period of record is 21 years at the West Ware gaging station near the Main Dam site is about 2,000 cubic feet per second and occurred April, 1923, or about 13 cubic feet per second per square mile. This peak lasted, roughly, three days. The largest New England flood of record in recent years occurred in November, 1927, and was felt probably most severely in Rhode Island, in the vicinity of the Squate Dam. Such a flood on the Quailin Reservoir watershed, if it came at a time when the reservoir was full, would result in a spillway discharge of about 2,000 cubic feet a second for a spillway weir 400 feet long. Records of large storms in western Massachusetts have produced rainfalls as high as 12 inches. Such a rainfall in a storm similar to the November, 1927, storm might produce a spillway discharge of about 3,000 cubic feet a second. A run-off of 12 inches in 24 hours would result in a spillway discharge of about 9,000 cubic feet a second.

Studies of such spillway sites revealed that, considering the use of excavated rock as riprap, the easterly site was more economical, and that it offered the better location structurally, as a discharge channel in rock all the way from the spillway weir to the river would be obtained. Because of these economic and structural advantages the easterly site has been adopted for location of the spillway weir and channel, but the natural features of the westerly site are also to be utilized by preparing at a slight extra cost this latter site as an additional insurance against overtopping of the dam in case of an unanticipated extreme emergency.

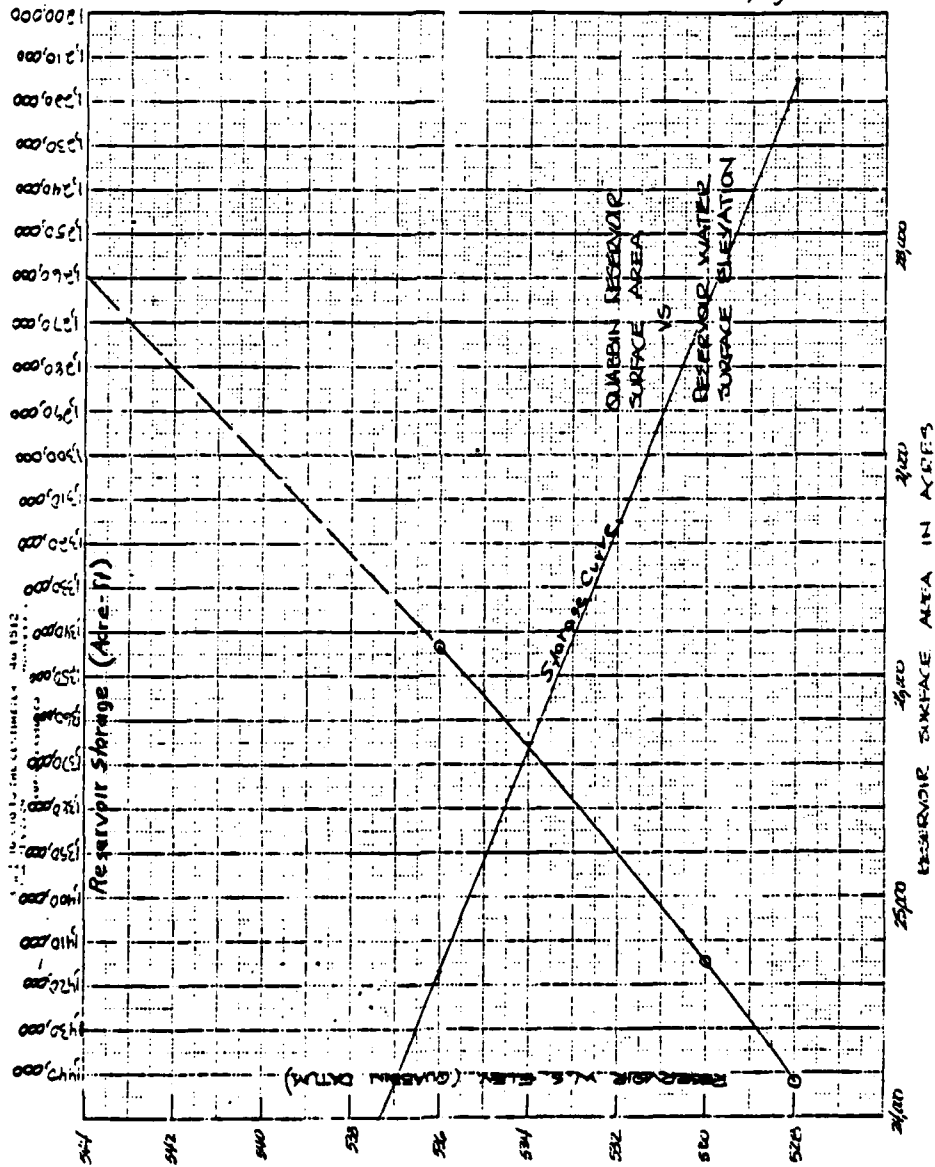
The easterly spillway channel will probably provide for carrying floods up to 10,000 cubic feet a second, without flooding out the rock discharge channel, and floods of considerably greater magnitude, even up to 15,000, will be carried with no important error of the earth banks above the rock channel. There is room at that site for a concrete overflow to be built in rock valley between hills about 400 feet long. With

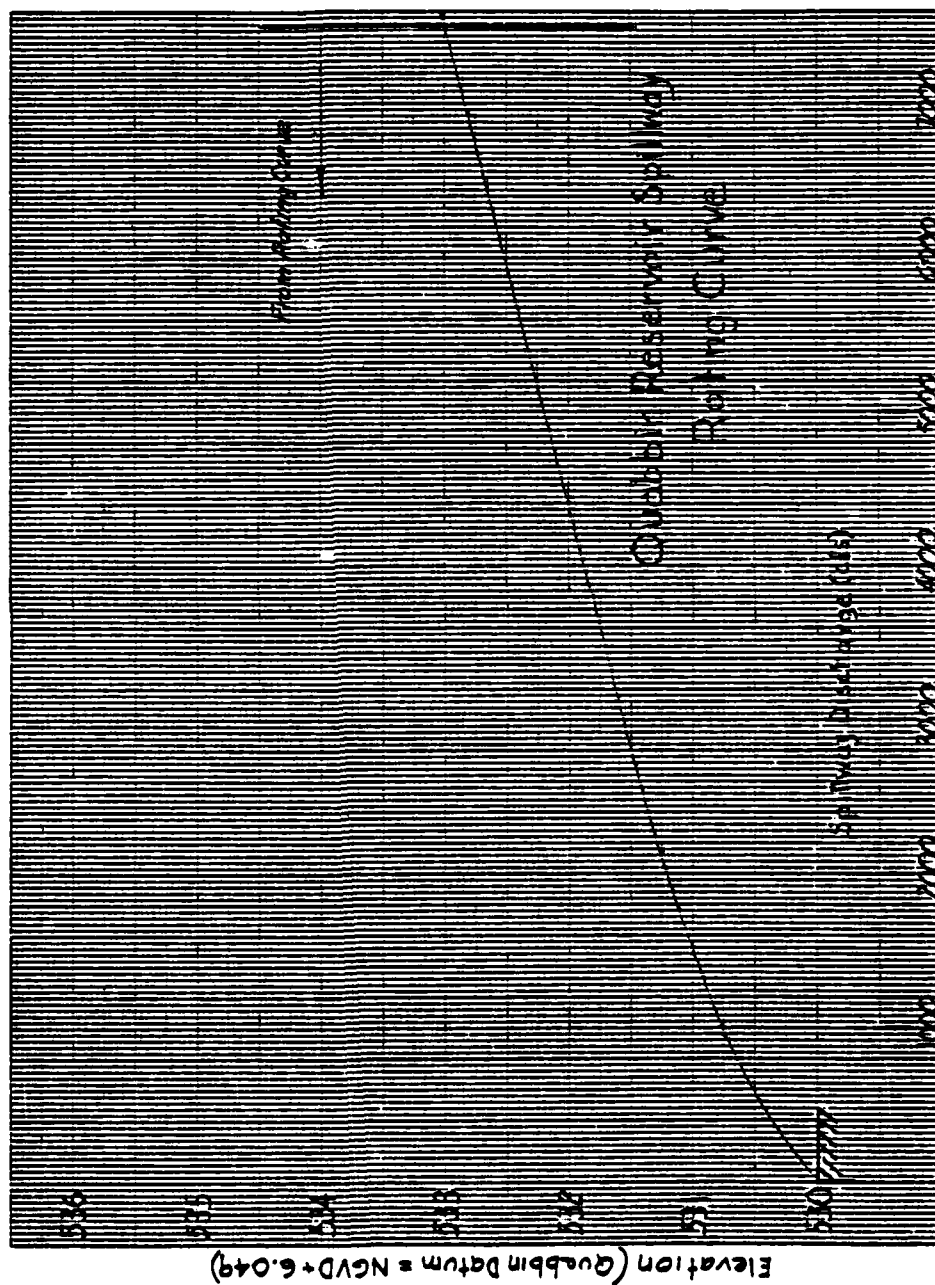
the reservoir full for three days the spillway at high as 13,000 cubic feet a second the reservoir will not be higher than 6 feet above Elev. 530. At the same time, at slight expense, by doing a little excavating and grading of the westerly weir site, and by building a shallow concrete cut-off to bridge there, an emergency overflow can be provided at Elev. 536 so that in case of an unanticipated extreme emergency, such as the chugging of the easterly spillway approach or discharge channels, or in case of unexpected and extremely high run-off with a full reservoir, a material rise in the reservoir surface above Elev. 536 will be practically prevented.

CROSS SECTION OF DAMS

The design of the section of the Dam is in keeping with general practice in large earth dams elsewhere, as can be seen from Fig. 8. A section of the Dam is shown in Fig. 1, and a tabulation comparing the Main Dam and Dike of Quailin Reservoir with other large earth dams is given in the appended table:

The top width of 35 feet has been chosen in order to provide a considerable width through the embankment at the higher elevations near the flow line in order to permit continuing the abutting property to as high an elevation as possible. The crestwidth of 20 feet between the spillway elevation and the top of embankment compares with 24 feet on the Cushmanville Dam, New York; 24 feet on the Paddy Creek Dam, North Carolina; 20 feet on the earth dams at Ashokan Reservoir, New York; 20 feet at Colville Mountain, Massachusetts (7 feet of which are flashboards); 19 feet on the Wyman Dam, Maine; 15 feet on the dikes of Wachusett Reservoir, Massachusetts; 15 feet on the Wanaque Dam, New Jersey; 14 feet on the Davis Bridge Dam, Vermont; 13 feet on the Squate Dam, Rhode Island, and 12 feet on the Saluda Dam, South Carolina. The downstream face has slopes of 1 on 2, 1 on 2½, and 1 on 2¾, with berms 15 feet wide to intercept the drainage at intervals of 35 to 50 feet vertically. On the upstream slope a wave break of heavy riprap with a horizontal berm 5 feet above the spillway level has been used, following generally the design of the Wachusett Reservoir Dike and the Squate Dam for the city of Providence, which has proved very satisfactory. Below this wave break a constant slope of 1 on 3, protected by riprap, has been carried to Elev. 458 for the Main Dam. Studies of the anticipated water levels during the filling of the reservoir and subsequent draw-downs during use indicate that to riprap below this elevation is not required. The wide berm at Elev. 458 is constructed of selected coarse material, with the idea it would take





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CLIENT 25 Broad St. - 1st Floor JOB NO. 9125-178
PROJECT 25 Broad St. - 1st Floor DATE CHECKED 9/25/78
DETAIL Handwritten CHECKED BY dlb

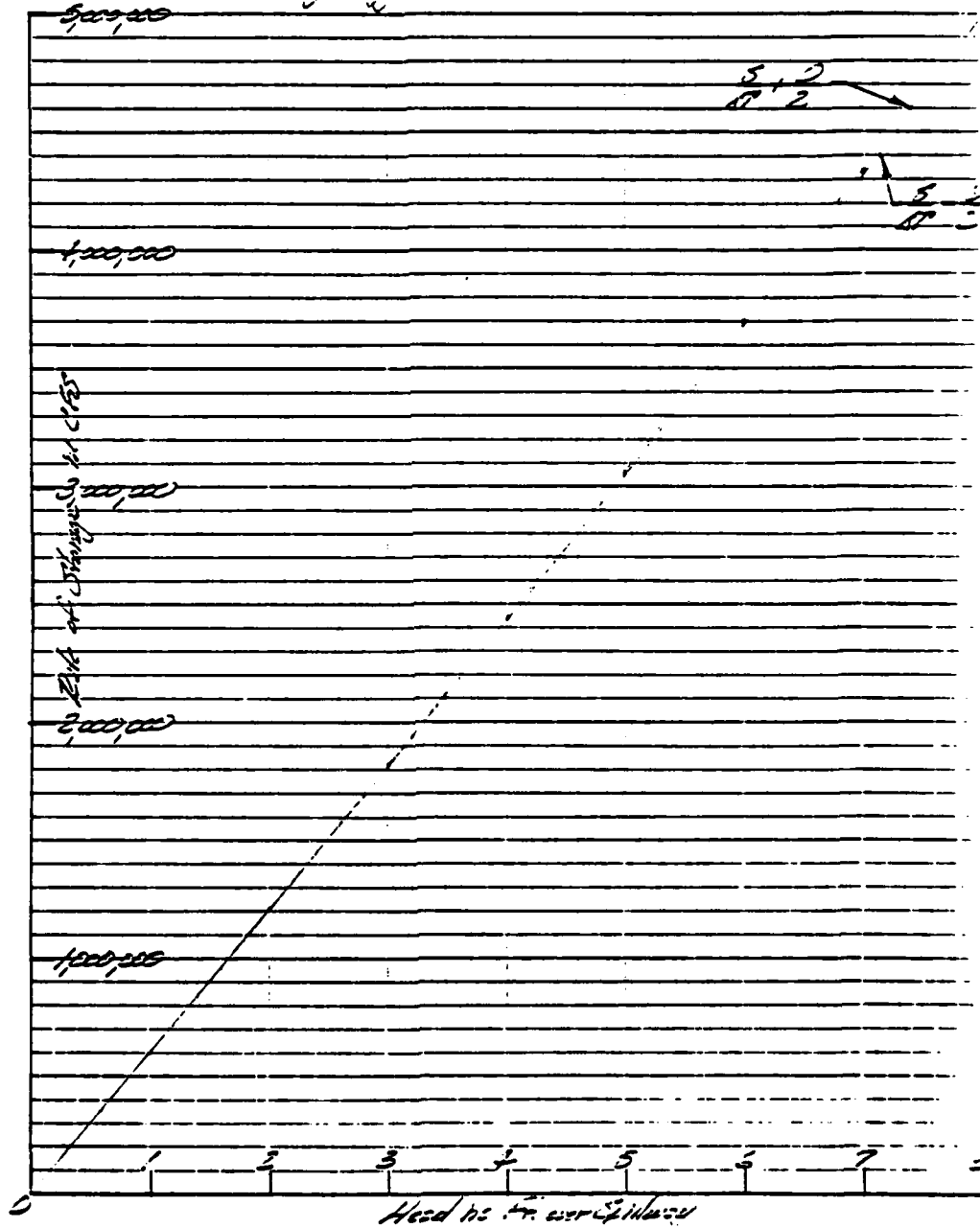
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<i>Column 1 to 7 - 1st Floor - 25 Broad St. - 1st Floor</i>						
<i>Reservoir</i>	<i>Reservoir</i>	<i>Calc.</i>	<i>Calc.</i>	<i>S</i>	<i>S - 2</i>	<i>S + 2</i>
<i>U.S.</i>	<i>Area, A</i>	<i>Area, A</i>	<i>Area, A</i>	<i>Area, A</i>	<i>Area, A</i>	<i>Area, A</i>
<i>Elm.</i>	<i>Elm.</i>	<i>Elm.</i>	<i>Elm.</i>	<i>Elm.</i>	<i>Elm.</i>	<i>Elm.</i>
530	24,700	0	0	0	0	0
531	24,950	1500	24,925	600,764	600,764	601,514
532	25,190	4,100	43,345	1,207,410	1,205,710	1,209,110
533	25,440	5910	75,310	1,200,090	1,217,130	1,233,210
534	25,680	7920	100,770	2,152,556	2,164,576	2,176,596
535	25,900	9930	126,540	3,652,753	3,657,213	3,667,513
536	26,120	11,830	152,570	3,692,113	3,694,753	3,697,393
537	26,340	13,330	173,300	4,254,810	4,257,830	4,260,850
538	26,550	15,340	205,245	4,256,925	4,259,043	4,261,161
<i>4" = 30,000 = 120,000</i>						
<i>Adjusted Forwarded Rates of 5 Stages - 25 Broad St. - 1st Floor</i>						
<i>Reservoir</i>	<i>Reservoir</i>	<i>Calc.</i>	<i>Calc.</i>	<i>S</i>	<i>S - 2</i>	<i>S + 2</i>
<i>U.S.</i>	<i>Area, A</i>	<i>Area, A</i>	<i>Area, A</i>	<i>Area, A</i>	<i>Area, A</i>	<i>Area, A</i>
<i>Elm.</i>	<i>Elm.</i>	<i>Elm.</i>	<i>Elm.</i>	<i>Elm.</i>	<i>Elm.</i>	<i>Elm.</i>
530	24,700	0	0	0	0	0
531	24,950	1,500	24,925	600,764	600,764	601,514
532	25,190	4,100	43,345	1,207,410	1,205,710	1,209,110
533	25,440	7,525	75,310	1,930,140	1,916,310	1,943,970
534	25,680	10,000	100,770	2,152,556	2,153,636	2,153,636
535	25,900	12,330	126,540	3,652,753	3,656,512	3,656,512
536	26,120	15,000	152,570	3,692,113	3,694,656	3,695,113
537	26,340	16,133	163,060	3,246,150	3,957,985	3,957,985
538	26,550	17,276	173,550	4,189,510	4,191,222	4,192,934
539	26,760	18,416	173,500	4,256,960	4,212,932	4,255,932

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CLIENT Atlantic City Biltmore Hotel • JOB NO. 54-0-27
PROJECT Sanitary Sewer DATE CHECKED 9/25/78
DETAIL Hydrology CHECKED BY dlb

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DATE 10/1/78
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Boston, Mass.

CLIENT Hydro-Land-Hill Inc.
PROJECT Gravel Pit
DETAIL Hydrology

JOB NO. 5-2-55
DATE CHECKED 7/25/75
CHECKED BY HLB

PAGE 29 of 35
DATE 7/25/75
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Calculation of Reservoir Outflows - Auxiliary Spillway Included

Time Hrs.	Obs. Inflow cfs	Average Inflow cfs	$E - \frac{D}{2}$	$E + \frac{D}{2}$	Head on Spillway ft.	Outflow cfs
0	0	0			0.10	43
1	35,140	12,530	60,276	77,656	0.12	56
2	50,310	32,735	72,375	110,310	0.13	107
3	63,100	56,705	102,935	166,640	0.23	169
4	75,920	62,500	166,325	235,775	0.39	334
5	151,340	113,530	235,137	345,757	0.54	629
6	226,790	189,665	327,237	536,552	0.79	1256
7	177,320	261,945	525,613	727,623	1.23	2125
8	127,610	156,265	755,762	893,174	1.92	2903
9	102,960	115,235	825,952	1001,744	1.66	3346
10	78,300	96,630	897,938	1043,613	1.90	3730
11	53,840	66,070	1082,646	1150,716	1.90	4110
12	29,390	41,610	1116,597	1133,207	1.96	4290
13	3,700	16,240	1183,920	1189,546	1.93	4350
14	5,560	3,100	1195,596	1198,696	1.99	4350
15	6,350	5,925	1195,344	1201,269	1.99	4320
16	7,200	6,775	1196,909	1203,624	1.99	4330
17	8,600	7,900	1199,312	1207,212	2.00	4410
18	10,000	9,300	1202,934	1212,124	2.00	4410
19	11,600	10,700	1207,719	1218,419	2.01	4444
20	12,200	12,100	1213,597	1226,256	2.25	4514
21	13,100	13,590	1221,656	1235,516	2.24	4542
22	14,500	16,200	1231,141	1247,441	2.06	4616
23	20,200	19,450	1242,587	1261,797	2.09	4713
24	22,800	21,550	1250,768	1273,918	2.11	4792
25	26,200	24,550	1274,267	1293,797	2.15	4910
26	29,600	27,200	1293,176	1322,076	2.13	5006
27	34,500	33,050	1312,387	1350,442	2.23	5166
28	45,500	36,000	1345,698	1385,692	2.29	5352
29	51,700	37,600	1390,960	1428,460	2.36	5576
30	60,000	55,250	1425,520	1479,370	2.44	5821
31	76,000	62,000	1474,301	1542,301	2.62	6132
32	82,000	82,200	1532,072	1621,072	2.67	6507
33	102,500	100,500	1615,659	1715,918	2.93	7015
34	125,000	116,750	1710,255	1827,003	3.01	7555
35	123,100	127,250	1821,070	1943,120	3.20	8019
36	133,200	131,150	1941,791	2075,946	3.40	9512
37	134,000	133,600	2063,220	2189,820	3.41	9733
38	133,300	133,650	2192,685	2326,335	3.81	9527
39	128,200	131,200	2319,785	2450,225	4.01	10025
40	125,000	127,100	2442,055	2563,155	4.20	10476
41	119,000	129,200	2565,580	2682,580	4.53	10540
42	113,000	116,000	2674,207	2796,207	4.56	11249
43	115,300	114,200	2781,197	2903,447	4.71	11761
44	52,000	98,250	2890,516	2979,526	4.26	12125

* 30-minute increments

CAMP DRESSER & MOORE
Environmental Engineers
Boston, Mass.

CLIENT: Massachusetts Department of Transportation
PROJECT: Cambridge - Lowell Expressway
DETAIL: Estimated

JOB NO. 71-5172
DATE CHECKED: 7/15/72
CHECKED BY: dlb

PAGE: 12
DATE: 7/15/72
COMPUTED BY: dlb

Sta.	Chg.	Adj.	S - D	A + D	Net on	Outflow
	10000	10000	ST	ST	Spillage	Q
45	82,350	91,425	3,169,272	3,040,699	4.39	12,465
46	83,240	86,275	3,050,841	3,137,116	5.11	12,757
47	79,350	81,525	3,127,016	3,223,541	5.22	13,224
48	75,000	77,175	3,159,312	3,255,389	5.22	13,312
49	71,000	73,200	3,261,214	3,322,050	5.43	13,414
50	67,510	69,600	3,327,315	3,396,913	5.52	13,739
51	64,700	66,550	3,335,930	3,452,239	5.61	14,217
52	61,600	63,150	3,441,133	3,524,289	5.62	14,318
53	58,300	59,450	3,493,023	3,553,973	5.70	14,446
54	55,000	56,650	3,545,321	3,602,071	5.85	14,557
55	51,400	53,450	3,550,656	3,643,946	5.81	14,775
56	48,300	50,350	3,632,234	3,682,229	5.90	14,950
57	46,400	47,600	3,670,257	3,718,357	6.13	15,277
58	44,000	45,200	3,706,445	3,751,612	6.03	15,205
59	42,000	43,000	3,723,577	3,722,597	6.13	15,332
60	40,000	41,000	3,772,451	3,717,451	6.13	15,461
61	37,750	38,375	3,789,315	3,729,310	6.22	15,525
62	35,500	36,625	3,825,769	3,762,254	6.26	15,666
63	33,500	34,500	3,843,933	3,801,459	6.39	15,741
64	31,500	32,500	3,872,031	3,804,524	6.32	15,810
65	29,850	30,675	3,952,002	3,922,677	6.35	15,912
66	28,300	28,025	3,910,091	3,829,116	6.38	15,975
67	26,850	27,525	3,926,873	3,954,203	6.40	16,024
68	25,500	26,175	3,841,313	3,967,293	6.22	16,375
69	24,250	24,975	3,854,766	3,979,661	6.24	16,126
70	23,000	23,625	3,946,975	3,990,502	6.36	16,172
71	21,800	22,400	3,977,702	4,000,100	6.47	16,213
72	20,600	21,200	3,987,771	4,008,371	6.69	16,254
73	19,450	20,025	3,995,614	4,015,634	6.50	16,290
74	18,300	18,975	4,002,760	4,021,635	6.51	16,324
75	17,150	17,875	4,008,253	4,026,613	6.52	16,352
76	16,000	16,625	4,013,639	4,030,724	6.52	16,383
77	14,800	15,400	4,017,292	4,033,574	6.53	16,392
78	13,600	14,200	4,021,062	4,036,252	6.53	16,395
79	12,400	13,000	4,023,507	4,038,167	6.53	16,395
80	11,200	11,800	4,025,319	4,039,314	6.54	16,393
81	10,000	10,600	4,026,765	4,039,665	6.54	16,393
82	8,800	9,400	4,026,710	4,039,510	6.54	16,393
83	7,600	8,200	4,026,558	4,039,358	6.54	16,393
84	6,400	7,000	4,025,555	4,037,605	6.52	16,393
85	5,200	5,800	4,024,457	4,035,507	6.52	16,393
86	4,000	4,600	4,023,264	4,033,764	6.52	16,393
87	2,800	3,400	4,022,089	4,032,089	6.52	16,393
88	1,600	2,200	4,020,931	4,030,931	6.52	16,393
89	400	1,000	4,019,782	4,029,782	6.51	16,393
90	0	0	4,018,634	4,028,634	6.51	16,393

8.16 DYNAMICS OF HYDROLOGIES

Table 3.3 Values of C in the Formula $Q = C/H^{3/2}$ for Broad-crested Weirs

Weir crest height, ft.	Depth of water above weir crest, ft.									
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
0.2	2.64	2.71	2.78	2.85	2.92	2.99	3.06	3.13	3.20	3.27
0.4	2.81	2.88	2.95	3.02	3.09	3.16	3.23	3.30	3.37	3.44
0.6	2.98	3.05	3.12	3.19	3.26	3.33	3.40	3.47	3.54	3.61
0.8	3.15	3.22	3.29	3.36	3.43	3.50	3.57	3.64	3.71	3.78
1.0	3.32	3.39	3.46	3.53	3.60	3.67	3.74	3.81	3.88	3.95
1.2	3.49	3.56	3.63	3.70	3.77	3.84	3.91	3.98	4.05	4.12
1.4	3.66	3.73	3.80	3.87	3.94	4.01	4.08	4.15	4.22	4.29
1.6	3.83	3.90	3.97	4.04	4.11	4.18	4.25	4.32	4.39	4.46
1.8	4.00	4.07	4.14	4.21	4.28	4.35	4.42	4.49	4.56	4.63
2.0	4.17	4.24	4.31	4.38	4.45	4.52	4.59	4.66	4.73	4.80
2.2	4.34	4.41	4.48	4.55	4.62	4.69	4.76	4.83	4.90	4.97
2.4	4.51	4.58	4.65	4.72	4.79	4.86	4.93	5.00	5.07	5.14
2.6	4.68	4.75	4.82	4.89	4.96	5.03	5.10	5.17	5.24	5.31
2.8	4.85	4.92	4.99	5.06	5.13	5.20	5.27	5.34	5.41	5.48
3.0	5.02	5.09	5.16	5.23	5.30	5.37	5.44	5.51	5.58	5.65
3.2	5.19	5.26	5.33	5.40	5.47	5.54	5.61	5.68	5.75	5.82
3.4	5.36	5.43	5.50	5.57	5.64	5.71	5.78	5.85	5.92	5.99
3.6	5.53	5.60	5.67	5.74	5.81	5.88	5.95	6.02	6.09	6.16
3.8	5.70	5.77	5.84	5.91	5.98	6.05	6.12	6.19	6.26	6.33
4.0	5.87	5.94	6.01	6.08	6.15	6.22	6.29	6.36	6.43	6.50
4.2	6.04	6.11	6.18	6.25	6.32	6.39	6.46	6.53	6.60	6.67
4.4	6.21	6.28	6.35	6.42	6.49	6.56	6.63	6.70	6.77	6.84
4.6	6.38	6.45	6.52	6.59	6.66	6.73	6.80	6.87	6.94	7.01
4.8	6.55	6.62	6.69	6.76	6.83	6.90	6.97	7.04	7.11	7.18
5.0	6.72	6.79	6.86	6.93	7.00	7.07	7.14	7.21	7.28	7.35
5.2	6.89	6.96	7.03	7.10	7.17	7.24	7.31	7.38	7.45	7.52
5.4	7.06	7.13	7.20	7.27	7.34	7.41	7.48	7.55	7.62	7.69
5.6	7.23	7.30	7.37	7.44	7.51	7.58	7.65	7.72	7.79	7.86
5.8	7.40	7.47	7.54	7.61	7.68	7.75	7.82	7.89	7.96	8.03
6.0	7.57	7.64	7.71	7.78	7.85	7.92	7.99	8.06	8.13	8.20

8.17 WEIRS

Table 3.5 Values of C in the Formula $Q = C/H^{3/2}$ for Broad-crested Weirs with Crests Inclined Slightly Downward

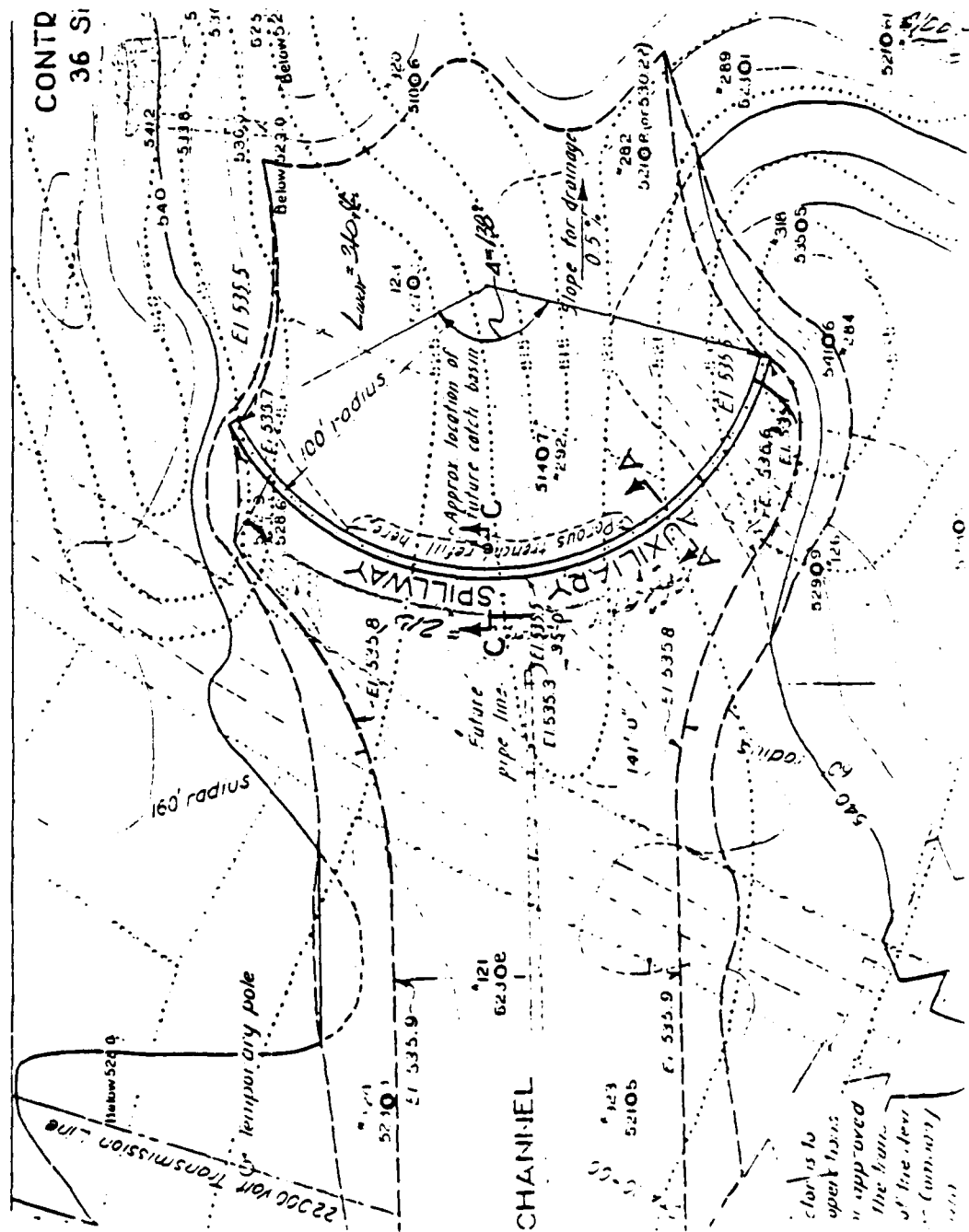
Crest height, ft.	Head in feet, H									
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
0.2	2.64	2.71	2.78	2.85	2.92	2.99	3.06	3.13	3.20	3.27
0.4	2.81	2.88	2.95	3.02	3.09	3.16	3.23	3.30	3.37	3.44
0.6	2.98	3.05	3.12	3.19	3.26	3.33	3.40	3.47	3.54	3.61
0.8	3.15	3.22	3.29	3.36	3.43	3.50	3.57	3.64	3.71	3.78
1.0	3.32	3.39	3.46	3.53	3.60	3.67	3.74	3.81	3.88	3.95
1.2	3.49	3.56	3.63	3.70	3.77	3.84	3.91	3.98	4.05	4.12
1.4	3.66	3.73	3.80	3.87	3.94	4.01	4.08	4.15	4.22	4.29
1.6	3.83	3.90	3.97	4.04	4.11	4.18	4.25	4.32	4.39	4.46
1.8	4.00	4.07	4.14	4.21	4.28	4.35	4.42	4.49	4.56	4.63
2.0	4.17	4.24	4.31	4.38	4.45	4.52	4.59	4.66	4.73	4.80
2.2	4.34	4.41	4.48	4.55	4.62	4.69	4.76	4.83	4.90	4.97
2.4	4.51	4.58	4.65	4.72	4.79	4.86	4.93	5.00	5.07	5.14
2.6	4.68	4.75	4.82	4.89	4.96	5.03	5.10	5.17	5.24	5.31
2.8	4.85	4.92	4.99	5.06	5.13	5.20	5.27	5.34	5.41	5.48
3.0	5.02	5.09	5.16	5.23	5.30	5.37	5.44	5.51	5.58	5.65
3.2	5.19	5.26	5.33	5.40	5.47	5.54	5.61	5.68	5.75	5.82
3.4	5.36	5.43	5.50	5.57	5.64	5.71	5.78	5.85	5.92	5.99
3.6	5.53	5.60	5.67	5.74	5.81	5.88	5.95	6.02	6.09	6.16
3.8	5.70	5.77	5.84	5.91	5.98	6.05	6.12	6.19	6.26	6.33
4.0	5.87	5.94	6.01	6.08	6.15	6.22	6.29	6.36	6.43	6.50
4.2	6.04	6.11	6.18	6.25	6.32	6.39	6.46	6.53	6.60	6.67
4.4	6.21	6.28	6.35	6.42	6.49	6.56	6.63	6.70	6.77	6.84
4.6	6.38	6.45	6.52	6.59	6.66	6.73	6.80	6.87	6.94	7.01
4.8	6.55	6.62	6.69	6.76	6.83	6.90	6.97	7.04	7.11	7.18
5.0	6.72	6.79	6.86	6.93	7.00	7.07	7.14	7.21	7.28	7.35

Table 3.6 Values of C in the Formula $Q = C/H^{3/2}$ for Weirs of Triangular Cross Section with Vertical Upstream Face and Slipping Downstream Face

Shape of downstream face	Head in feet, H									
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
1 to 1	2.64	2.71	2.78	2.85	2.92	2.99	3.06	3.13	3.20	3.27
2 to 1	2.81	2.88	2.95	3.02	3.09	3.16	3.23	3.30	3.37	3.44
3 to 1	2.98	3.05	3.12	3.19	3.26	3.33	3.40	3.47	3.54	3.61
4 to 1	3.15	3.22	3.29	3.36	3.43	3.50	3.57	3.64	3.71	3.78
5 to 1	3.32	3.39	3.46	3.53	3.60	3.67	3.74	3.81	3.88	3.95
6 to 1	3.49	3.56	3.63	3.70	3.77	3.84	3.91	3.98	4.05	4.12
7 to 1	3.66	3.73	3.80	3.87	3.94	4.01	4.08	4.15	4.22	4.29
8 to 1	3.83	3.90	3.97	4.04	4.11	4.18	4.25	4.32	4.39	4.46
9 to 1	4.00	4.07	4.14	4.21	4.28	4.35	4.42	4.49	4.56	4.63
10 to 1	4.17	4.24	4.31	4.38	4.45	4.52	4.59	4.66	4.73	4.80

Table 3.4 Values of C in the Formula $Q = C/H^{3/2}$ for Models of Broad-crested Weirs with Round Upstream Corner

Name of experiment	Head in feet, H									
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
1 to 1	2.64	2.71	2.78	2.85	2.92	2.99	3.06	3.13	3.20	3.27
2 to 1	2.81	2.88	2.95	3.02	3.09	3.16	3.23	3.30	3.37	3.44
3 to 1	2.98	3.05	3.12	3.19	3.26	3.33	3.40	3.47	3.54	3.61
4 to 1	3.15	3.22	3.29	3.36	3.43	3.50	3.57	3.64	3.71	3.78
5 to 1	3.32	3.39	3.46	3.53	3.60	3.67	3.74	3.81	3.88	3.95
6 to 1	3.49	3.56	3.63	3.70	3.77	3.84	3.91	3.98	4.05	4.12
7 to 1	3.66	3.73	3.80	3.87	3.94	4.01	4.08	4.15	4.22	4.29
8 to 1	3.83	3.90	3.97	4.04	4.11	4.18	4.25	4.32	4.39	4.46
9 to 1	4.00	4.07	4.14	4.21	4.28	4.35	4.42	4.49	4.56	4.63
10 to 1	4.17	4.24	4.31	4.38	4.45	4.52	4.59	4.66	4.73	4.80



AD-A155 515

NATIONAL PROGRAM FOR INSPECTION OF NON-FEDERAL DAMS
WINSOR DAM (MA 00588)...(U) CORPS OF ENGINEERS WALTHAM
MA NEW ENGLAND DIV SEP 78

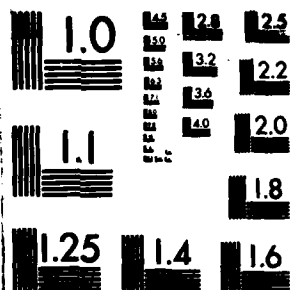
2/3

UNCLASSIFIED

F/G 17/17

NI

											END DATE 8-1-78			



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

CAMP DRESSER & MOORE
Environmental Engineers
Boston, Mass.

CLIENT: U.S. Army Corps of Engineers JOB NO. 5412-277
PROJECT: COASTAL DEFENSE - PORT CHARLOTTE CHECKED: 9/25/78
DETAIL: PORT CHARLOTTE CHECKED BY: ALB

PAGE: 211
DATE: 9/25/78
COMPUTED BY: ALB

Port Charlotte Port

Channel width at low tide is 200 ft. Channel width at high tide is 250 ft. Channel depth at low tide is 10 ft. Channel depth at high tide is 15 ft. Channel width at low tide is 200 ft. Channel width at high tide is 250 ft. Channel depth at low tide is 10 ft. Channel depth at high tide is 15 ft.

Station	Depth	Width	Area	Volume	Weight
536.0	0	0	0	15,000	15,000
536.3	0.2	24	15.28	15,500	15,565
536.6	0.4	25	13.24	16,000	16,133
536.9	0.6	25	24.42	16,500	16,266
537.2	0.8	25	575.7	17,000	17,376
537.5	1.0	25	546	17,500	17,446

CAMP DRESSER & MOORE
Environmental Engineers
Boston, Mass.

CLIENT Habitat 66/67 - 1st & 2nd Regs. JOB NO. 64-1-2-577
PROJECT Site Plan - 1st & 2nd Regs. DATE CHECKED 9/15/78
DETAIL 4/25/78-52 CHECKED BY ALB

PAGE 5/12 of 16
DATE 10/1/78
COMPUTED BY 10/1/78

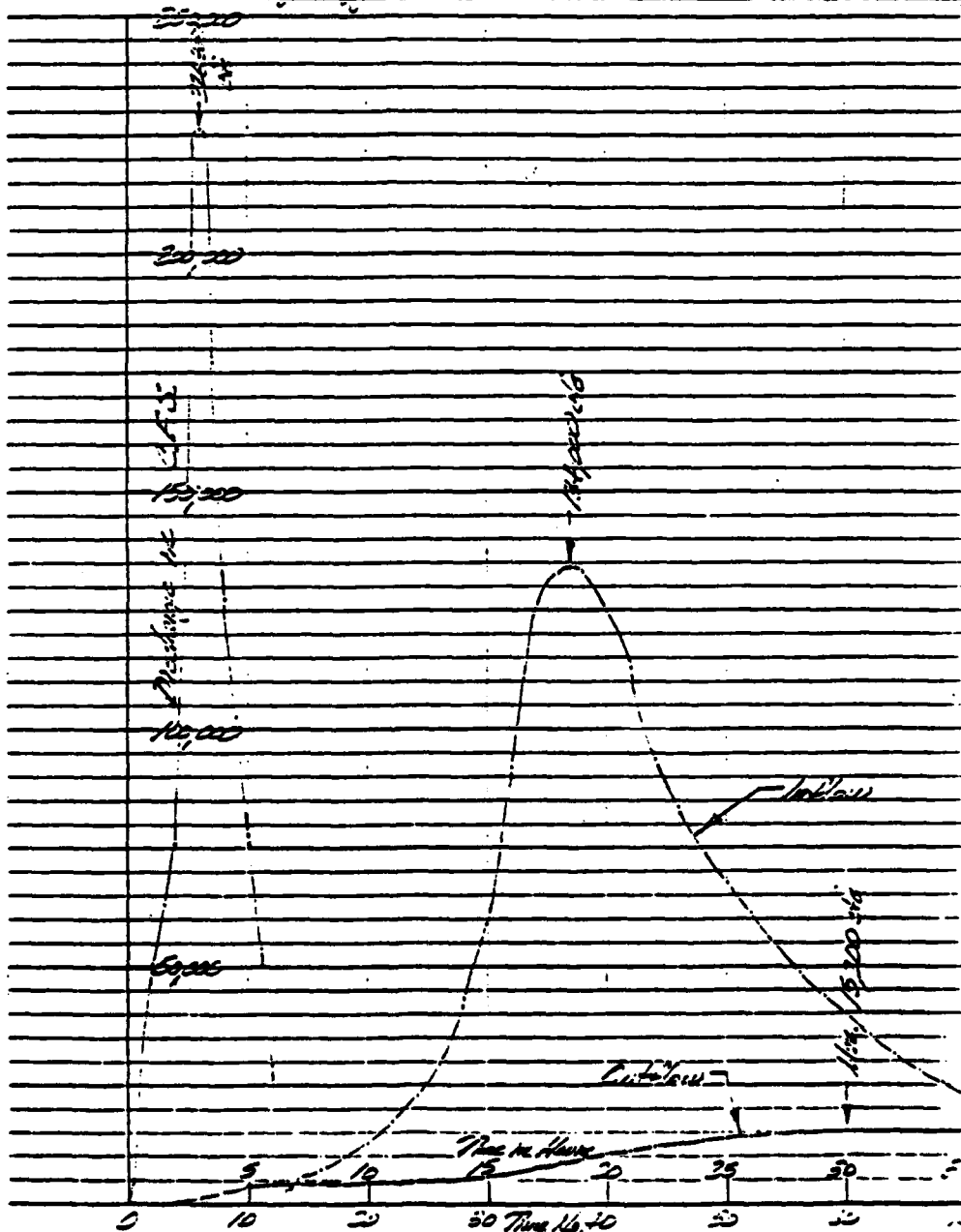
Calculations for Recreational Services - Recreation Facilities Section

Time Lg.	Cost (\$/hr)	Charge (\$/hr)	2 - 2 21' =	2 + 2 21' =	Hourly Expense	Outlay (\$)
55	21.800	53.150	3,590,150	3,615,846	5.91	14,775
56	20.800	52.350	3,629,149	3,674,510	5.97	14,854
57	20.800	47.600	3,661,550	3,715,180	6.02	15,256
58	24.000	45.200	3,616,600	3,731,800	6.05	15,140
59	21.000	45.400	3,687,515	3,760,515	6.06	15,170
60	20.800	41.000	3,710,051	3,711,951	6.07	15,152
61	37.750	39.875	3,715,553	3,719,553	6.06	15,140
62	35.500	36.625	3,720,711	3,757,559	6.06	15,170
63	33.500	33.500	3,695,763	3,754,763	6.05	15,140
64	31.500	33.500	3,653,461	3,753,761	6.05	15,140
65	29.250	30.875	3,637,146	3,757,321	6.04	15,113
66	29.000	29.225	3,655,936	3,756,971	6.04	15,113
67	26.850	27.525	3,604,741	3,723,266	6.04	15,113
68	25.500	26.175	3,695,482	3,719,359	6.03	15,095
69	23.250	24.875	3,650,715	3,717,600	6.03	15,085
70	23.000	23.625	3,619,826	3,715,451	6.02	15,053

CAMP DRESSER & MAKEE
Environmental Engineers
Boston, Mass.

CLIENT U.S. Army Corps of Engineers JOB NO. 551-2-17
PROJECT Bridge - Over Oak River DATE CHECKED 9/15/78
DETAIL Hydrology CHECKED BY alld

PAGE 12
DATE 9/15/78
COMPUTED BY alld



CAMP DRESSER & MAKER
Structural Engineers
Boston, Mass.

CLIENT UNITED STATES
PROJECT WINNERS DAM
DETAIL SPILLWAY DESIGN

JOB NO. 861-9-01
DATE CHECKED 9/25/78
CHECKED BY ALD

PAGE 01
DATE 2-14-72
COMPUTED BY ALD

DAM FAILURE ANALYSIS

SPILLWAY CREST EL. 530.0
EMERGENCY (OVERFLOW) SPILLWAY CREST EL. 536.0
TOP OF DAM EL. 550.0

IT IS PHYSICALLY IMPOSSIBLE FOR THE RESERVOIR WATER SURFACE ELEV. TO REACH THE TOP OF DAM (EL. 550.0), AS THE EMERGENCY SPILLWAY WILL RELEASE OVERFLOWS AT EL. 536.0. ALSO THE ESTIMATED PUF SURCHARGE POOL LEVEL IS EL. 536.2

... ASSUME WATER LEVEL AT EL. 536.0 AT TIME OF FAILURE

STORAGE AT EL. 536.0 = 1,417,500 cu ft. of 428 billion gal.

WINNERS DAM

HEIGHT AT EL. 550.0 = 170'
" " " 536.0 = 136'

LENGTH = 2,340', ASSUME $W_b = 20\%$
 $\therefore W_b = 2,340 \times .2 = 468 \text{ ft.}$

$$G_p = 8/27 \times 468 \times (32.2)^{1/2} (136)^{3/2} = 1,553,000 \text{ lbs.}$$

GOLDENROUGH DIKE

HEIGHT AT EL. 550.0 = 135'
" " " 536.0 = 121'

LENGTH = 2,140', ASSUME $W_b = 20\%$
 $\therefore W_b = 2,140 \times .2 = 428 \text{ ft.}$

$$G_p = 8/27 \times 428 \times (32.2)^{1/2} (121)^{3/2} = 956,000 \text{ lbs.}$$

MAIN SPILLWAY

W.S. ELEV. 536.0
MIN. ELEV. OF LADGE EL. 505.0

Let $W_b = 40\%$ of 370 ft. = 148 ft.

$$G_p = 8/27 (148) (32.2)^{1/2} (148)^{3/2} = 13,575 \text{ lbs.}$$

less than test pool

History of the Lake Superior Program for Corps of Engineers June 29, 1978
Quabbin Reservoir - Field Trip - H.P. Mink & Mrs. Hollaway - H.P.
Quabbin plans @ 20 January 84 - WDC Office Roger W. C. Lawrence
SCE Fellow - C.D.

Water Division - B.H. Allen
 9th floor

Today - US E. 528.73 BCB { Note: 6.000 is cost @ Quabbin for
 528.73 BCB to USGS - not 5.65 as usually stated
 "Red"

(based on original construction) - Harold W. Wiley
 Harold Wiley, Sept.

Public Document No. 147 - Quabbin Dam & Quabbin Reservoir - General
 Construction Data - Bureau of Reclamation

In 22 years that Harry Wiley has been here, no modifications have been made to
 these data, like on spillway. Something seems was added to the data in
 1966 - plans by C.D. - cost by R.H. Wiley

CAMP DESIGN & MONITOR
Environmental Engineers
Boston, Mass.

CLIENT Michael Pollack - Fox Corporation JOB NO. 24-0-22
PROJECT Design for Open & Closed DATE CHECKED _____
DETAIL Drainage Basin CHECKED BY _____

PAGE E/26
DATE June 29, 1978
COMPUTED BY Miller

Drainage Basin of Pond - 8:00 am to 10:00 am

Quartz Spillway - 10:15 am to 11:45 am

Spillway Length - 900 ft.

Crest Elev 530.0 (BCB) - stone capped wall flow

Elev 528.0 (BCB) - 5 bay spillway with 2 ft. thick boards (3 bays @ 8")

Width - varies in place

Location - 6000 NE of main intake works

Number of types of gates - None

Note: area and organic overgrowth under surface crest & ft. of spillway

rectification incl. spillage depth exceeds 6" Also heavy logs & small

branches just up & do. ft. and by 10 ft. of crest should be removed

Note: left (out) rock face of spillway discharge channel shows

considerable overgrowth with rock deposited in channel about midway

between spillway and stone arch bridge do. covered by M.D.

Note: check out channel approach upstream of overgrowth about 100' up

of spillway with thick boards. Channel narrows to 30'-60' from

10-15' width or.

CAMP DRESSER & MOORE
Environmental Engineers
Boston, Mass.

CLIENT: Wahasset Wildlife - Duck Department JOB NO. W-10-100
PROJECT: Wahasset Wildlife - Duck Department DATE CHECKED: _____
DETAIL: Wahasset Wildlife - Duck Department CHECKED BY: _____

PAGE: 3 of 6
DATE: 12/1/78
COMPUTED BY: Wahasset Wildlife - Duck Department

Wahasset Wildlife - 10:30 am to 1:00 pm

Inspection, installed structural (R. Wood) and greenhouse (C. Lawrence)
at structure of equipment. Note: structure was installed in 1966 by R.H. White
with plans & specs. by CDL.

Emergency Spillway - 1 pm to 1:30 pm



Bank overflow section - slope upward about 4' from
structure which is 2' above W.S. - i.e. spillway 6' above W.S.
Good grass and soil cover - a few minor places where soil
has been removed. Look to soil around bank above spillway before
digging to natural terrain.

Power House - 2 pm to 3:30 pm

Inspection installed structural (R. Wood) and greenhouse (C. Lawrence)
at structure of equipment. We also observed 400 yd. of by-pass channel from power
station up to under dam.

CAMP OVERSEER & MAINT
Environmental Engineer
Boston, Mass.

CLIENT Robert A. Blum - President, L.D. No. 54-2-27
PROJECT Blum for L.D. No. 54-2-27 DATE CHECKED _____
DETAIL Blum for L.D. No. 54-2-27 CHECKED BY _____

PAGE E-3 of 6
DATE June 29, 1978
COMPUTED BY Blum

Robert A. Blum - President, L.D. No. 54-2-27

Blum for L.D. No. 54-2-27

12' wide x 9' high corr. metal plate oak - L.D. No. 54-2-27

CAMP DRESSER & MILES
Environmental Engineers
Roxbury, Mass.

CLIENT Worcester County - Dept. of Highway JOB NO. 34-0-27
PROJECT Design for Dept. of Highway DATE CHECKED _____
DETAIL Quabbin Reservoir CHECKED BY _____

PAGE 3 of 6
DATE June 29, 1978
COMPUTED BY W. Fisher

QUABBIN RESERVOIR - Elevation - Capacity Data

<u>Elev.</u> <u>(ft.)</u>	<u>Cap.</u> <u>(MG)</u>	<u>Elev.</u> <u>(ft.)</u>	<u>Cap.</u> <u>(MG)</u>
501.0	214,000	523.0	359,100
502.0	219,700	524.0	366,600
503.0	225,400	525.0	374,100
504.0	231,200	526.0	381,600
505.0	237,100	527.0	389,100
506.0	243,100	528.0	396,600
507.0	249,100	529.0	404,100
508.0	255,100	530.0	412,240 Spillway Crest
509.0	261,200	530.2	413,929
510.0	267,200	530.4	415,629
511.0	274,100	530.6	417,340
512.0	280,700	530.8	419,063
513.0	287,800	531.0	420,800
514.0	294,100	531.2	422,549
515.0	300,900	531.4	424,310
516.0	307,800	531.6	426,083
517.0	314,900	531.8	427,868
518.0	322,100	532.0	429,670
519.0	329,400	532.2	431,488
520.0	336,700	532.4	433,322
521.0	344,100	532.6	435,172
522.0	351,600	532.8	437,038
		533.0	438,920

CAMP DRESSER & MOORE
Environmental Engineers
Boston, Mass.

CLIENT W. B. Egan - Dan. Department JOB NO. 54-2-22
PROJECT Quabbin Res. Spillage to Swift River DATE CHECKED _____
DETAIL Quabbin Reservoir CHECKED BY _____

PAGE 5.5
DATE June 21, 1970
COMPUTED BY CD

QUABBIN RESERVOIR - Spillage to Swift River

<u>1970</u>	<u>W.B. Egan</u>	<u>French</u>	<u>1976</u>	<u>W.B. Egan</u>	<u>French</u>
April 16	520.01	2.0	April 2	520.02	6.0
17	04	12.0	3	08	21
18	07	26.0	4	13	63
19	15	70.0	5	14	70
20	21	129.0	6	13	63
21	27	188.0	7	11	49
22	31	234.0	8	10	43.2
23	32	246.0	9	08	31
24	34	269.0	10	04	12
25	34	269.0	11	03	9
26	23	257.0	12	530.01-04	27.4
27	33	267.0			
28	31	234.0			
29	29	210.0			
30	27	188.0			
May 1	26	178.0			
2	21	129.0			
3	15	70.0			
4	11	44.0			
5	09	37.0			
6	05	16.3			
7	05	114.0 6.0			
8	520.00	0			

last previous spillage in 1961

Highest Elev. 531.03 Apr. 18, 1953

Lowest Elev. 495.70 Nov. 5, 1967

E 646

Mar 4, 1976 - 164.8 M.G. total
Mar 1, 1976 253.0 cfs } max rate
El. 529.89 163.5 mgd }
no logs - 5 bags open

Spillway discharged this year - first time since 1976 - no spillage
from 1961 till 1976

April 24, 1978 - El. 532.34 269.0 cfs - 173.8 mgd
all logs in place - no bags open

APPENDIX E
INFORMATION CONTAINED IN
THE NATIONAL INVENTORY OF DAMS

INVENTORY OF DAMS IN THE UNITED STATES

FED ID	DIVISION	STATE	COUNTY	NAME	LATITUDE		LONGITUDE		REPORT DATE
					NORTH	WEST	NORTH	WEST	
1A	NRD	MA	015	QUABBIN WINSON DAM	4217.0	7220.6			08SEP78

POPULAR NAME	NAME OF IMPONDMENT
QUABBIN	HESEKVOIN

RECORD NO.	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01 00	SHIFT RIVER		0	6679

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STATE	HYDRAULIC	IMPOUNDING CAPACITIES	DIST UMN	FED R	PRV/PED	SCS A	VER/DAIL
HECTPG	1939	9	280	170	1010000	1265200	NEO	N	N	28AUG78

REMARKS

RCS	SILLWAY	MAXIMUM DISCHARGE (CFS)	VOLUME OF DAM (CU YD)	POWER CAPACITY (KW)	NAVIGATION LOCKS
1	2000	C	405	15000	4000000

OWNER	ENGINEERING BY	CONSTRUCTION BY
METROPOLITAN DIST, COMM	METROPOLITAN DIST, COMM	BENJAMIN FOSTER COMPANY

DESIGN	REGULATORY AGENCY	
	CONSTRUCTION	OPERATION
NONE	NONE	MA DPA

INSPECTION BY	INSPECTION DATE		AUTHORITY FOR INSPECTION	
	DAY	MO		YR
MALEY & ALDRICH, INC.	29	JUN	78	PUBLIC LAW 92-367

REMARKS

INVENTORY OF DAMS IN THE UNITED STATES

NAME	QUABBIN SPILLWAY	STATE	MA	COUNTY	FRANKLIN	REPORT DATE	08 SEP 78
TYPE OF DAM	SPILLWAY	YEAR COMPLETED	1938	PURPOSES	8	POPULATION	8079
NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	WAKE	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	WAKE	POPULATION	8079	REPORT DATE	08 SEP 78

POPULAR NAME	QUABBIN RESERVOIR	NAME OF INFUMENT	QUABBIN RESERVOIR
NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	WAKE	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	WAKE
POPULATION	8079	POPULATION	8079

TYPE OF DAM	CHPG	YEAR COMPLETED	1938	PURPOSES	8	POPULATION	8079
NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	WAKE	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	WAKE	POPULATION	8079	REPORT DATE	08 SEP 78

REMARKS	
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TYPE OF DAM	CHPG	YEAR COMPLETED	1938	PURPOSES	8	POPULATION	8079
NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	WAKE	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	WAKE	POPULATION	8079	REPORT DATE	08 SEP 78

OWNER	METROPOLITAN DIST. COMM.	ENGINEERING BY	METROPOLITAN DIST. COMM.
DESIGN	NONE	CONSTRUCTION	NONE

REGULATORY AGENCY	OPERATION	MAINTENANCE	MA DPH
INSPECTION BY	INSPECTION DATE	AUTHORITY FOR INSPECTION	PUBLIC LAW 92-367

INSPECTION BY	INSPECTION DATE	AUTHORITY FOR INSPECTION	PUBLIC LAW 92-367
WALLEY & ALUMICH, INC.	29 JUN 78	PUBLIC LAW 92-367	

REMARKS	
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[illegible]

POPULAR NAME	NAME OF INFUMENT
	QUADRAIN RESERVOIR

WATER BODY	NAME OF STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST. FROM DAM (M.I.)	POPULATION
01-00	BEAVER BROOK	WARE	0	8079

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)
TYPE OF DAM	YEAR COMPLETED	PURPOSES	VALUE IN \$1000	VALUE IN \$1000	STATION	STATION	STATION	STATION	STATION
HECTIC	1930	3	200	135	181000	1265200			

DISPATCH	DATE	TIME	FROM	TO	REMARKS
101	20 AUG 70	1000	FM	TO	1000
102	20 AUG 70	1005	FM	TO	1005
103	20 AUG 70	1010	FM	TO	1010
104	20 AUG 70	1015	FM	TO	1015
105	20 AUG 70	1020	FM	TO	1020
106	20 AUG 70	1025	FM	TO	1025
107	20 AUG 70	1030	FM	TO	1030
108	20 AUG 70	1035	FM	TO	1035
109	20 AUG 70	1040	FM	TO	1040
110	20 AUG 70	1045	FM	TO	1045
111	20 AUG 70	1050	FM	TO	1050
112	20 AUG 70	1055	FM	TO	1055
113	20 AUG 70	1100	FM	TO	1100
114	20 AUG 70	1105	FM	TO	1105
115	20 AUG 70	1110	FM	TO	1110
116	20 AUG 70	1115	FM	TO	1115
117	20 AUG 70	1120	FM	TO	1120
118	20 AUG 70	1125	FM	TO	1125
119	20 AUG 70	1130	FM	TO	1130
120	20 AUG 70	1135	FM	TO	1135
121	20 AUG 70	1140	FM	TO	1140
122	20 AUG 70	1145	FM	TO	1145
123	20 AUG 70	1150	FM	TO	1150
124	20 AUG 70	1155	FM	TO	1155
125	20 AUG 70	1200	FM	TO	1200
126	20 AUG 70	1205	FM	TO	1205
127	20 AUG 70	1210	FM	TO	1210
128	20 AUG 70	1215	FM	TO	1215
129	20 AUG 70	1220	FM	TO	1220
130	20 AUG 70	1225	FM	TO	1225
131	20 AUG 70	1230	FM	TO	1230
132	20 AUG 70	1235	FM	TO	1235
133	20 AUG 70	1240	FM	TO	1240
134	20 AUG 70	1245	FM	TO	1245
135	20 AUG 70	1250	FM	TO	1250
136	20 AUG 70	1255	FM	TO	1255
137	20 AUG 70	1300	FM	TO	1300
138	20 AUG 70	1305	FM	TO	1305
139	20 AUG 70	1310	FM	TO	1310
140	20 AUG 70	1315	FM	TO	1315
141	20 AUG 70	1320	FM	TO	1320
142	20 AUG 70	1325	FM	TO	1325
143	20 AUG 70	1330	FM	TO	1330
144	20 AUG 70	1335	FM	TO	1335
145	20 AUG 70	1340	FM	TO	1340
146	20 AUG 70	1345	FM	TO	1345
147	20 AUG 70	1350	FM	TO	1350
148	20 AUG 70	1355	FM	TO	1355
149	20 AUG 70	1400	FM	TO	1400
150	20 AUG 70	1405	FM	TO	1405
151	20 AUG 70	1410	FM	TO	1410
152	20 AUG 70	1415	FM	TO	1415
153	20 AUG 70	1420	FM	TO	1420
154	20 AUG 70	1425	FM	TO	1425
155	20 AUG 70	1430	FM	TO	1430
156	20 AUG 70	1435	FM	TO	1435
157	20 AUG 70	1440	FM	TO	1440
158	20 AUG 70	1445	FM	TO	1445
159	20 AUG 70	1450	FM	TO	1450
160	20 AUG 70	1455	FM	TO	1455
161	20 AUG 70	1500	FM	TO	1500
162	20 AUG 70	1505	FM	TO	1505
163	20 AUG 70	1510	FM	TO	1510
164	20 AUG 70	1515	FM	TO	1515
165	20 AUG 70	1520	FM	TO	1520

REMARKS

[illegible]

C	C	C
OWNER	ENGINEERING BY	CONSTRUCTION BY
METROPOLITAN DIST, COMM	METROPOLITAN DIST, COMM	ARTHUR A. JOHNSON CORP.

	REGULATORY AGENCY			
	DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE		NONE	NONE	MA O/P

INSPECTION BY		INSPECTION DATE		AUTHORITY FOR INSPECTION	
MALEY & ALDWINCH, INC.		DAY	MO	YR	PUBLIC LAW 42-367
				29 JUN 78	

REMARKS	48-EMBANKMENT CONTRACT



INVENTORY OF DAMS IN THE UNITED STATES

STATE	UNIVERSITY	PROJECT	DATE	CONTRACT	NAME	REPORT DATE
MA	500	NED	MA	015	01	DAY MO YR
QUABBIN SPILLWAY						4217.2 7220.3 UNSELP/B

POPULAR NAME	NAME OF IMPROVEMENT
QUABBIN RESERVOIR	

NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	POPULATION
NEAREST RIVER ON STREAM	0
NAME	0079

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STATUS	IMPROVING CAPACITIES
GRPC	1930 S		10	1010000 1200200

DIST UAN FED M INV/PED SCS A VEN/DATE
N N N N 28AUG78

REMARKS

D/S	SPILLWAY	MAXIMUM	WORKING	POWER CAPACITY	NAVIGATION LOCKS
MA	TYPE	CHARGE	OF DAM	INSTALLED	NO
5	435	5	35	15000	

OWNER	ENGINEERING BY	CONSTRUCTION BY
METROPOLITAN DIST. COUN.	METROPOLITAN DIST. COUN.	

DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	MA UP

INSPECTION BY	INSPECTION DATE	AUTHORITY FOR INSPECTION
MALEY & ALUMICH, INC.	24JUL78	PUBLIC LAW 92-367

REMARKS



INVENTORY OF DAMS IN THE UNITED STATES

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
STATE	FED	STATE	COUNTY	NAME	LATITUDE	LONGITUDE	REPORT DATE												
VA	590	NED	MA	015	01	QUABBIN GUDDNOUGH DIKE	4217.0	7210.0	0082P70										

POPULAR NAME		NAME OF IMPROVEMENT	
QUABBIN RESERVOIR			
1	2	3	4
NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST	POPULATION
01 00 BEAVER BROOK	NARE	0	8070

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
TYPE OF DAM	YEAR COMPLETED	PURPOSES	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY	HYDRAULIC POWER CAPACITY
RECIPRO	1930	3	200	135	1010000	1265200	NED	N	N	N	N	N	N	N	N	N	N	N	N

REMARKS	

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE																
1	2100	N	2700000																

OWNER	ENGINEERING BY	CONSTRUCTION BY
METROPOLITAN DIST, COMM	METROPOLITAN DIST, COMM	ARTHUR A. JOHNSON CORP.

DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	MA UPN

INSPECTION BY	INSPECTION DATE	INSPECTION DATE
MALEY & ALUMICH, INC.	29 JUN 70	PUBLIC LAN 42-367

REMARKS	
48-EMBANKMENT CONTRACT	

INVENTORY OF DAMS IN THE UNITED STATES

STATE	COUNTY	DISTRICT	SECTION	NAME	REPORT DATE
MA	SPO	NED	MA 015 01	QUABBIN SPILLWAY	DAY MO YR 01 01 1978

POPULAR NAME	NAME OF FOUNDMENT
	QUABBIN RESERVOIR

INNER OR STREAM	NEAREST DOWNSTREAM CITY - TOWN - VILLAGE	POPULATION
SHIFT RIVER		8074

TYPE OF DAM	YEAR COMPLETED	PURPOSES	HYDRAULIC CAPACITY	STORAGE CAPACITY	NAVIGATION LOCKS
CRPC	1938	3	10	10	10

REMARKS

DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	MAINTENANCE

OWNER	ENGINEERING BY	CONSTRUCTION BY
METROPOLITAN DIST. COMM.	METROPOLITAN DIST. COMM.	

DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	MAINTENANCE

INSPECTION BY	INSPECTION DATE	AUTHORITY FOR INSPECTION
MALEY + ALDRICH, INC.	29 JUN 78	PUBLIC LAW 92-367

REMARKS

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL

NEDED-E

SUBJECT

Dam Inspection Final Report

TO

Chief, Design Branch
Chief, F & M Branch
Chief, Water Control Branch

FROM

Chairman,
Dam Safety Review Board

DATE 4 Oct. 78

CMT 1

1. Attached is a single copy of the final report for Winsor Dam, Quabbin Spillways & Good enough Dike, Identity No. MA 00589, 00589 & 00590.
2. Please ascertain that the report is acceptable in accordance with your Branch comments or instructions given to the Architect-Engineer at the Review Board Meeting.
3. If acceptable, retain the copy for your files and be prepared to sign the (master) approval sheet on 10 Oct.
4. If the report requires further work or correction, notify the undersigned as soon as the determination is made.
5. The cost code for this review is ABA020700000000.

Tiersch

TIERSCH

Incl
as

DISPOSITION FORM

For use of this form, see AR 340-15, the proponent agency is TAGCEN.

REFERENCE OR OFFICE SYMBOL

NEDED-E

SUBJECT

Dam Inspection Final Report

TO

Chief, Design Branch
Chief, F & M Branch
Chief, Water Control Branch

FROM

Chairman,
Dam Safety Review Board

DATE 4 Oct. 78

CMT 1

1. Attached is a single copy of the final report for Winsor Dam, Quabbin Spillway, Identity No. MA 00500, 00509 & 00590.
Good enough Dike
2. Please ascertain that the report is acceptable in accordance with your Branch comments or instructions given to the Architect-Engineer at the Review Board Meeting.
3. If acceptable, retain the copy for your files and be prepared to sign the (master) approval sheet on 9 Oct.
4. If the report requires further work or correction, notify the undersigned as soon as the determination is made.
5. The cost code for this review is ABA020700000000.

Tiersch

TIERSCH

Incl
as

This Phase I Inspection Report on Windsor Dam, Quabbin Spillway & Goodnough Dike has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.



CHARLES G. TIERSCH, Chairman
Chief, Foundation and Materials Branch
Engineering Division




FRED J. RAVENS, Jr., Member
Chief, Design Branch
Engineering Division



SAUL COOPER, Member
Chief, Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:



JOE B. FRYAR
Chief, Engineering Division

DATE
FILMED
-8